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08828

Distr.
LIMITED

UNIDO/IOD.251
29 March 1979

ENGLISH

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

MANNING AND TRAINING SCHEDULES

FOR ALUMINIUM SMELTERS IN DEVELOPING COUNTRIES *

by

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(Argentina)**

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id.79-2383

FOREWORD

by UNIDO Secretariat

This Report is written for aluminium smelter people, but especially for those who plan aluminium smelters in developing countries.

The paper provides detailed information on manpower requirements of this industry and on the necessary education and training pre-requisites of the staff. These are elaborated primarily keeping in mind conditions in developing countries.

The preparation of such a Report was recommended by the participants in UNIDO's Workshop on Case Studies of Aluminium Smelter Construction in Developing Countries, held in Vienna in June 1977, which was attended by 26 experts from 17 developing and developed countries.

Data and information for this study were collected from 22 companies, running 84 smelters in 25 countries of the world. The helpful contribution of all persons and companies who provided data and information and enabled related visits to their offices and plants is highly appreciated.

The preparation of this paper is, in UNIDO's practice, a pioneer undertaking of experimental character. UNIDO would greatly appreciate receiving the opinion of readers, as well as suggestions for further similar projects.

Manning and Training Schedules for Aluminium Smelters in Developing Countries

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Introduction Background and Purpose of the Present Report

The Second General Conference of the United Nations Industrial Development Organization (UNIDO), held at Lima, Peru, in March 1975, stressed the important role of industrial development and outlined various measures to be undertaken at the national, regional, and and global levels to enhance the contribution of industry to the introduction of a new international economic order. The Lima Declaration and Plan of Action on Industrial Development and Cooperation (ID/CONF. 3/31, Chapter IV), adopted by the Second General Conference, established a target: the developing countries' share of world industrial production is to reach a minimum of 25 percent by the year 2000. The Lima Declaration and Plan of Action contains a call to the developing countries to establish production facilities covering all branches of industry aimed at meeting the basic needs of their people. Parallel to this effort, UNIDO is to prepare a concrete co-operative program of action to promote the creation, transfer and use of appropriate industrial technology for developing countries, primarily related to specific branches of industry and to social conditions.

In the last twenty years much experience has been gained in the construction and operation of primary aluminium smelters in developing countries. As a result, the developing countries' share of world primary aluminium production has gone from about 2 percent in 1957-58 to about 10 percent in 1976-77.

The expansion of aluminium smelter capacity in developing countries continues. A preliminary estimate based on known project figures shows that by the end of 1983 the developing countries' share of world primary aluminium production capacity is likely to be as high as 18.4 percent. The target of 25 percent by the year 2000 is therefore not unrealistic as far as the primary aluminium industry is concerned.

In the effort to develop national capabilities and capacity, cooperation between the industrialized and the developing countries, and between the developing countries themselves, is of fundamental importance because it would help bring about an exchange of information and the sharing of relevant experience and know-how at all levels.

In line with the above considerations, UNIDO conceived a Workshop on Case Studies of Aluminium Smelter Construction in Developing Countries, held at Vienna, from 27 to 29 June 1977 which was opened by the Director of UNIDO's Industrial Operations Division.

The workshop had the following three main objectives:

(a) To assess up-to-date experience in activities related to the planning, construction and operation of aluminium smelters in developing countries;

(b) to provide a forum for the first-hand exchange of the above experience;

(c) to help identify fields of priority for UNIDO technical assistance for the primary aluminium smelter industry.

Reflecting the third of these objectives, one point in the Agenda of the Workshop was:

Discussion on conclusions and recommendations, including those concerning UNIDO's technical assistance in the aluminium smelter sector.

Among these conclusions and recommendations, the participants in the Workshop put forward the following (see the Workshop Final Report, Document ID/WG. 250/18, page 35, paragraph 151.4):

"UNIDO should prepare a working document that would facilitate the training of aluminium smelter staff in developing countries. This document should contain a set of educational and experience qualifications and should describe typical training programmes. It should also include a standard set of manning and training schedules, possibly on the basis of a standard aluminium smelter of about 100,000 tons/year capacity. A compilation of experience in training personnel to operate smelters in developing countries could supplement the document. Participants from developing and developed countries offered to provide contributions for the preparation of such a document; UNEP offered to contribute to a chapter on environmental control."

In compliance with the above recommendation, UNIDO contracted the preparation of the document suggested with one of the participants at the Workshop. The document, entitled "Manning and Training Schedules for Aluminium Smelters in Developing Countries," is presented in the pages that follow.

Chapter 1 - MANNING SCHEDULES FOR ALUMINIUM SMELTERS

Section 1.1 Some Statistics on Aluminium Production and Existing Smelters

Aluminium has a short, and rather paradoxical, history. Short because the technology to produce it was developed less than a hundred years ago while most other common metals, such as iron, copper, tin, zinc, lead, silver and gold have been mined, refined and fabricated for thousands of years. It is paradoxical because although aluminium is, by far, the most abundant element in the Earth's crust, it was not isolated and recognized to be a chemical element until 1825, when the Danish physicist and chemist, Oerstead, obtained it in pure form in the laboratory.

However, aluminium has compensated for its late start in the metal race by the swiftness of its development, to the point that today its production is second only to steel, measured by weight, volume, or monetary value.

It is also interesting to note that the basic technology employed to produce aluminium has not changed since it was first developed, simultaneously but independently, by Hall in the U.S.A. and Heroult in France in 1886. Today about 99.9% of the world's primary aluminium production capacity is still based on the Hall-Heroult electrolytic method, and practically all new capacity under construction or in the planning stage continues to be based on that same technology.

In view of the above, the present report assumes, as we shall see in more detail in Chapter 2, Section 2.1, that smelters to be built during the coming years in developing countries will continue to use the Hall-Heroult process. The assumption is quite safe. In spite of some promising recent developments, it does not appear likely that the aluminium industry is about to witness a major revolution in production technology. Further, there is no reason for the developing countries to be the first to adopt technologies still in the developmental stage. Therefore, there is no justification to consider here manning schedules for smelters based on any other but the Hall-Heroult process.

According to information provided by aluminium companies and obtained from official publications of mining and industrial Bureaus of several countries, there were in December, 1978 a total of 170 smelters in the world with a total annual production capacity of about 16.7 million tonnes. These smelters were distributed over 40 countries, as indicated in Table 1. The distribution is far from even. Just three countries, the U.S.A., U.S.S.R. and Japan have 52.6% of the world's production capacity, while the share of the sixteen developing countries which appear in the list is only 13.2%. We shall return to this point at the end of the present Section.

Next we shall look at the sizes and ages of smelters. Figures 1 and 2 show the distribution of smelters by size. In Figure 1 the vertical scale gives the number of smelters in a given size range, while Figure 2 gives the percentage of world

Table 1

Aluminium Production Capacity in the World at the End of 1978

Country	Number of Smelters	Total Annual Capacity in MT	% of World Capacity
Argentina	1	140,000	0.84
Australia	3	249,000	1.49
Austria	2	92,000	0.55
Bahrain	1	120,000	0.72
Brazil	4	195,000	1.16
Cameroon	1	62,000	0.37
Canada	6	1,066,000	6.37
China (People's Rep.)	10	253,000	1.51
Czechoslovakia	1	65,000	0.39
Egypt	1	100,000	0.60
France	10	410,000	2.45
German Dem. Republic	2	85,000	0.51
Fed. Rep. of Germany	10	762,000	4.55
Ghana	1	200,000	1.19
Greece	1	145,000	0.87
Hungary	3	75,000	0.45
Iceland	1	76,000	0.45
India	6	340,000	2.03
Italy	6	286,000	1.71
Iran	1	50,000	0.30
Japan	14	1,622,000	9.69
Korea (South)	1	18,000	0.11
Mexico	1	45,000	0.27
Netherlands	2	266,000	1.59
New Zealand	1	150,000	0.90
Norway	8	721,000	4.31
Poland	2	110,000	0.66
Romania	1	200,000	1.19
South Africa	1	80,000	0.48
Spain	4	218,000	1.30
Surinam	1	66,000	0.39

Table 1 (cont'd.)

Country	Number of Smelters	Total Annual Capacity in MT	% of World Capacity
Sweden	1	85,000	0.51
Switzerland	3	88,000	0.53
Taiwan	2	75,000	0.45
Turkey	1	60,000	0.36
United Kingdom	5	373,000	2.23
United States	32	4,744,000	28.33
U.S.S.R.	14	2,445,000	14.60
Venezuela	2	400,000	2.39
Yugoslavia	3	205,000	1.22
TOTALS	170	16,742,000	

FIGURE 1

DISTRIBUTION OF SMELTER BY SIZE

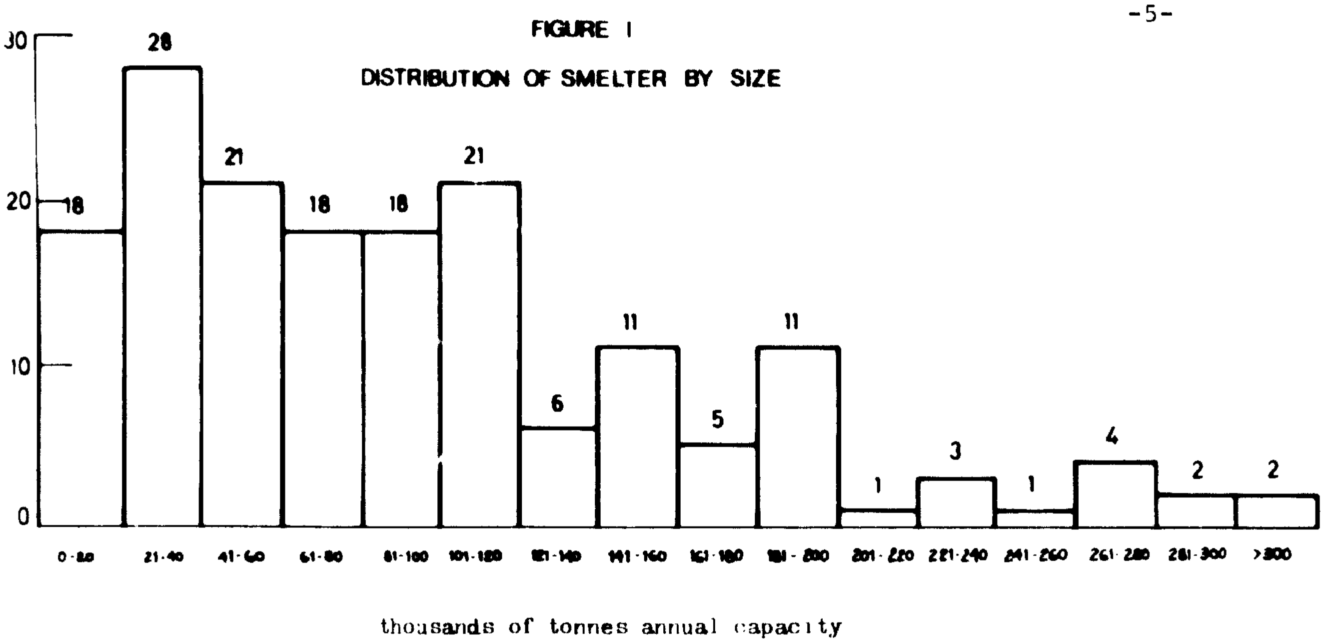
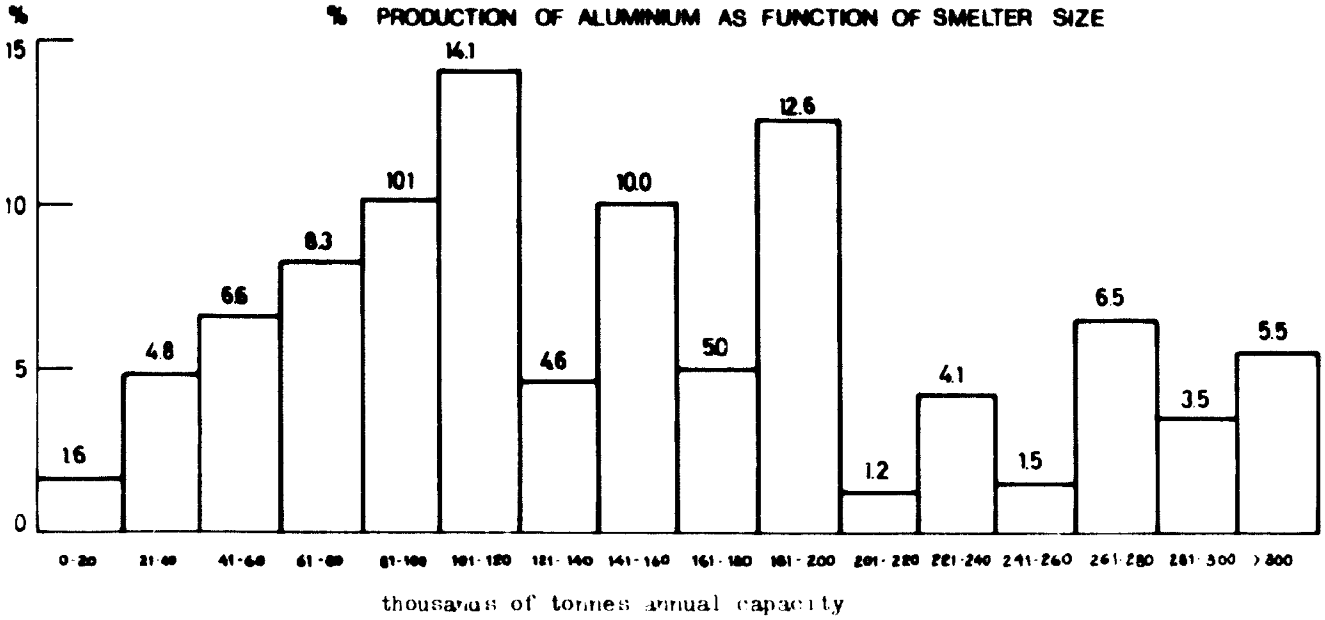


FIGURE 2

% PRODUCTION OF ALUMINIUM AS FUNCTION OF SMELTER SIZE



production as a function of smelter size. The median size of smelters turns out to be 64000 tonnes/year, but half the world's capacity is distributed over only 40 smelters larger than 140,000 tonnes/year. With regard to age, it is interesting to see (Figure 3*) that there are still nine smelters in operation at sites first developed before 1910. On the other hand, only six new sites have been developed during the last four year period, compared to thirty new sites in the period January '70 through December '74. The figure also shows the ages of twenty five smelters in fifteen developing countries (the only developing country not included is China because of the lack of data). By 1950 the developing countries had 4 smelters out of a world total of 56 (7.1%), by 1960 they had 6 out of 84 (7.1%), by 1970 the ratio was 14 out of 120 (11.7%) and today it is 25 out of 156 (16%) or, including China and other smelters for which I do not have a construction date, it is 35 out of 170 (20.6%). The trend for increasing participation of developing countries in the production of primary aluminium is quite evident, and it is likely to continue in the future.

Such trend is brought forward very clearly by Table 2, which shows the contribution of the developing countries to the world production of metal, and by Table 3 which shows the known production capacity of different regions of the world at the end of 1978, the expected production capacities at the

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*Only 156 smelters are included in this figure. I was unable to ascertain the ages of the ten smelters in China, the two smelters in the German Democratic Republic, one smelter in Japan and one in France.

FIGURE 3

NUMBER OF NEW SMELTERS BUILT IN EACH DECADE

(STILL OPERATIONAL)

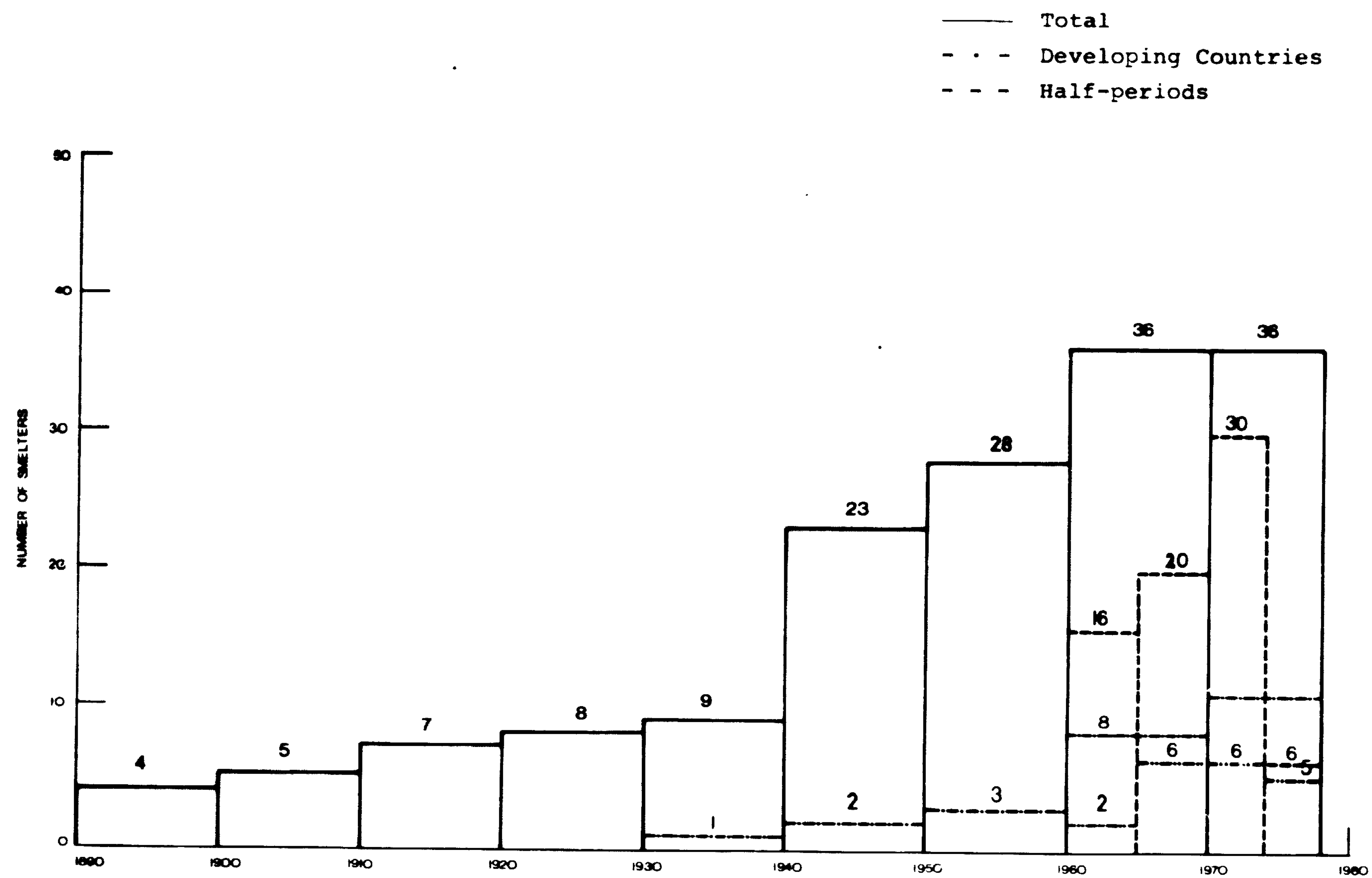


Table 2

Aluminium Production in Developing Countries

Year	World Total (thousand tonnes)	Developing Countries (thousand tonnes)	% Developing Countries
1957	3330	53	1.57
1958	3521	88	2.50
1959	4065	156	3.84
1960	4524	169	3.74
1961	4723	195	4.13
1962	5064	219	4.32
1963	5508	243	4.41
1964	6112	272	4.45
1965	6729	287	4.27
1966	6881	322	4.68
1967	7571	373	4.93
1968	8054	502	6.23
1969	8968	590	6.58
1970	9644	653	6.77
1971	10320	762	7.39
1972	10994	907	8.25
1973	12127	967	7.98
1974	13172	1026	7.79
1975	12116	1284	10.60
1976	12497	1301	10.41
1977	14079	1317	9.35

Table 3

Aluminium Production Capacity for 1978 and 1983[1]

Region or Country	End of 1978 (thousands of tonnes)	End of 1983 (thousands of tonnes)	% Annual Increase
Canada	1066	1252	2.72
Eastern Europe	3745	4125	1.62
Western Europe	3679	4104	1.84
Japan	1577	1583	0.06
Oceania	399	582	6.49
U.S.A.	4716	5063	1.19
TOTAL DEVELOPED	15182	16709	1.61
Africa	442	696	7.86
Asia (exc. Japan)	949	1737	10.60
Latin America	733	1346	10.66
TOTAL DEVELOPING	2124	3779	10.08
TOTAL WORLD	17306	20488	2.85

[1] Primary Aluminium Plants-Worldwide, U.S. Bureau of Mines, Washington, D. C., July 1978.

end of 1983, and the annual rate of growth of production capacity for each region. The numbers, of course, cannot be absolutely accurate since some announced projects may be cancelled and others not yet conceived or revealed may be implemented, but the general picture is unlikely to change. (For consistency both the 1978 and 1983 year end capacities were taken from the same source, namely "Primary Aluminum Plants, Worldwide," published by the Bureau of Mines of the United States in July 1978.) It is hard to predict whether the same trend will continue into the nineties; if nuclear power, for example, becomes more competitive with hydroelectricity, aluminium production capacity may shift back to the more industrialized countries. However, further expansion of the aluminium industry, in the developing countries, particularly in those generously endowed with bauxite or easily accessible sources of hydroelectric power will undoubtedly continue. And so will their manpower requirements.

Section 1.2 Smelters Selected for the Present Study

The Terms of Reference prepared by UNIDO for the present study stated that: "Data will be collected from as many as possible of all existing smelters of comparable size and technology to smelters to be built in the future. Criteria: prebaked anodes; amperage > 100,000 A; capacity > 70,000 MT/year." If the preceding criteria are applied, somewhat loosely in the case of developing countries, to all existing smelters (see Table 1), it turns out that 66 plants can be defined as "modern" according to such criteria. For each one of these 66 smelters the first task was the determination of their respective ownership and suppliers of technology. Once this was done, the task of requesting the desired information could begin. Appendix 1 lists the firms that responded positively to our request. Table 4 lists the smelters on which information was received. In some cases the amount of information provided was too limited to be of use to the present study; in other cases the information was presented in such a way that it was difficult to compare it with the data from other smelters. However, it was finally possible to choose a group of six smelters in North America and three in Western Europe that could be used as examples of the most up-to-date technology in developed countries, with the highest rate of primary aluminum production per employee. This group of nine smelters which are identified with an asterisk in Table 4 could then be used as a "measuring rod" and compared to smelters in developing countries in any analysis concerning organization, productivity, working conditions, and so forth.

With regard to smelters in developing countries, all those for which sufficient data were received were included in the study. In Table 4 they are shown with a double asterisk.

The response from the aluminum companies consulted was extremely uneven. Four of the so-called "big six" were extremely

Table 4

Smelters on Which Information was Received

Country or Region	Location	Owner	Capacity	Technology Supplier	Technology Call
U.S.A.	Badin, North Carolina*	Alcoa	114000	Alcoa	PB
	Massena, N.Y.*	Alcoa	195000	Alcoa	PB
	Alcoa, Tenn.*	Alcoa	195000	Alcoa	PB
	Frederick, Md.*	Eastalco	160000	Pechiney	PB
	Ferndale, Wash.*	Intalco	236000	Pechiney	PB
	Howesville, Ky.*	Nat.Southwire	163000	Kaiser/Nat.South.	PB
Europe	Hamburg, Fed. Rep. of Germany*	Hamburger, Aluminium Werke	100000	Reynolds	PB
	Distomon, Greece	Aluminium de Grece	145000	Pechiney	PB
	Bolzano, Italy	Alumetal	45000	Alumetal	S
	Mori, Italy	Alumetal	20000	Alumetal	S/PB
	Fusina, Italy	Alumetal	36000	Alumetal	PB
	P.Vesme,Sardinia, Italy	Alsar	125000	Alumetal/Pechiney	PB
	Vlissingen,Netherl.*	Pechiney Ned.	170000	Pechiney	PB
	San Cipriano,Spain	Aluminio Espanol	180000 (1)	Pechiney	PB
	Lynemouth, U.K.*	Alcan, U.K.	120000	Alcan	PB
Latin America	Pto. Madryn, Argentina**	Aluar	144000	Alumetal	PB
	Saramenha,Brazil	Alcan Brazil	54000	Alcan	S
	Aratu, Brazil	Alcan,Brazil	28000	Alcan	S
	Sorocaba, Brazil	C. B. A.	80000	Alumetal/Pechiney	S
	Pocos de Caldas, Brazil	Alcominas	60000	Alcoa	S
	Santa Cruz, Brazil**	Valesul	85000 (1)	Reynolds	PB
	Belem, Brazil**	Valenorte	320000 (1)	Mitsui	PB

Table 4 (cont'd.)

Country or Region	Location	Owner	Capacity	Technology Supplier	Call
Latin America	Paranam, Surinam**	Suralco	66000	Alcoa	S
	Pto.Ordaz,Venezuela**	Alcasa	120000	Reynolds	PB
	Pto.Ordaz,Venezuela**	Venalum	280000	Reynolds	PB
Africa	Edea, Cameroon**	Pechiney	62000	Pechiney	S
	Nag Hammadi, Egypt**	Egyptalum	100000	U.S.S.R.	S
	Tema, Ghana**	Valco	200000	Kaiser	PB
Asia	Knuff, Bahrain**	Alba	120000	Alumetal/Kaiser	PB
	Madras, India	Madras Alum	25000	Alumetal	S
	Korba, India**	Bharat Alum	100000	U.S.S.R.	S
	Belgaum, India	Indian Al.Co.	75000	Alcan	PB
	Arak, Iran**	Iralco	50000	Reynolds	PB
	Omachi, Japan	Showa, Al.	41000	?	PB
	Kitakata, Japan	Showa, Al.	28000	?	S
	Chiba, Japan	Showa, Al.	160000	?	S/PB
	Ulsan, Korea**	Koralu	18000	Pechiney	S
	Dubai, U.A.E.	Dubal	135000(1)	National/Southwire	PB
Oceania	Kurri-Kurri,Australia	Alcan	45000	Alcan	PB
	Point Henry,Australia	Alcoa	92000	Alcoa	PB

(1) Under construction

cooperative. They answered the questionnaires in detail, and made arrangements for personal interviews in their offices and/or visits to smelters either owned by them or using their technology. Of the other two, one sent very complete and valuable information on one particular smelter, but declined to cooperate further, while the other did not make available any information at all. Of the smaller companies in developed countries, response was either excellent or an absolute zero, in about equal numbers.

From the developing countries the response was excellent, both from the few privately owned smelters and from the government owned companies. It would have been interesting to receive information from China, a country where more than half of the metal produced is claimed to come from nine smelters of less than 20,000 tonnes per year average capacity. Although it seems to go against the generally accepted ideas, one should not discard the possibility that local consumption in developing countries may be satisfied very well by smelters of considerable smaller size than is deemed "economical" in the industrialized countries.

Section 1.3 Questionnaires Prepared and Firms Consulted

A first Questionnaire, transcribed below, was prepared for the group of six transnational corporations that dominate the production of aluminium outside the block of countries with centrally planned economies. The Questionnaire reads as follows:

Questionnaire

For all primary smelters in operation or under construction using technology supplied by your company, I would appreciate receiving the information indicated below. Please keep in mind that the information will be used to prepare a document that will have unrestricted distribution. You should indicate, therefore, if some items in my final report must be kept confidential or be used only in aggregated statistics. I assume full responsibility for seeing to it that no person other than myself will have access to the original information that is sent to me, and that no part of my report in which your information is used will be made public without giving you the opportunity to verify that the information was used in a manner you approve. Please feel free to leave questions unanswered, to combine questions, to aggregate smelters, to send printed brochures; on the other hand, please try to answer as fully as possible.

I. General Information on the Smelters

1. Ownership: (Please indicate if your company has: a)100% ownership; b) less than 100% but at least 51%; c) 50% or less; d) no part of the equity.)
2. Location.
3. Original Plant: year of actual or expected start up and initial capacity
4. Expansions: year of actual or expected start up and added capacity
5. Main parameters of the cell (Soderberg or pre-baked; amperage; daily production; side or center brake; relining in situ or outside of cell building; operations performed from the floor and from cranes)
6. What functions in the smelter--other than administrative--are carried out by computers? List and describe the computers. Were they installed when the plant was built or introduced later? Are you planning to introduce further automation?
7. Brief description of carbon plant and rodding operation. Do you: a) buy anodes? b) produce just what the plant needs?; c) sell anodes?

8. Brief description of cast house, including product mix. Do you ship metal in liquid form?
9. Brief description of pollution control facilities
10. Brief description of raw materials handling and storage

II. <u>Specific Information on Personnel</u>

1. General organization chart of the smelter
2. Total number of persons employed; break down according to skills (i.e., unskilled, semiskilled and skilled workers, clerks, foremen, engineers, etc.), break down according to Sections or Departments (i.e., green carbon plant; electrolysis; cast house; anode baking; maintenance; administration, etc.)
3. Job descriptions, including minimum qualifications of prospective personnel
4. In-house training programs
5. Functions performed by contractors (e.g., electrical and mechanical maintenance; maintenance of building and grounds; security; cleaning; medical services, etc.)
6. In the case of smelters in developing countries: a) numbers and positions of expatriates as a function of time since start-up; b) numbers and positions of indigenous personnel trained in other plants of technology supplier and average length of training; c) expected date of substitution of remaining expatriates by indigenous personnel.

Obviously, the above Questionnaire had to be slightly modified in the case of companies which are not suppliers of technology, or which own only one smelter, or which do not have any interests in developing countries. However, the scope of the information requested was, in essence, the same and hence it is unnecessary to reproduce the variations to the above. The list of firms which responded to this questionnaire, or parts of it, can be found in Appendix 1.

Section 1.4 Data Collected - Analysis and Conclusions

A. Productivity

For fifteen smelters, eight in developing and seven in developed countries, it was possible to obtain detailed information on the number of employees. For one smelter in a developing country, information was also provided about the personnel expected when capacity is doubled.

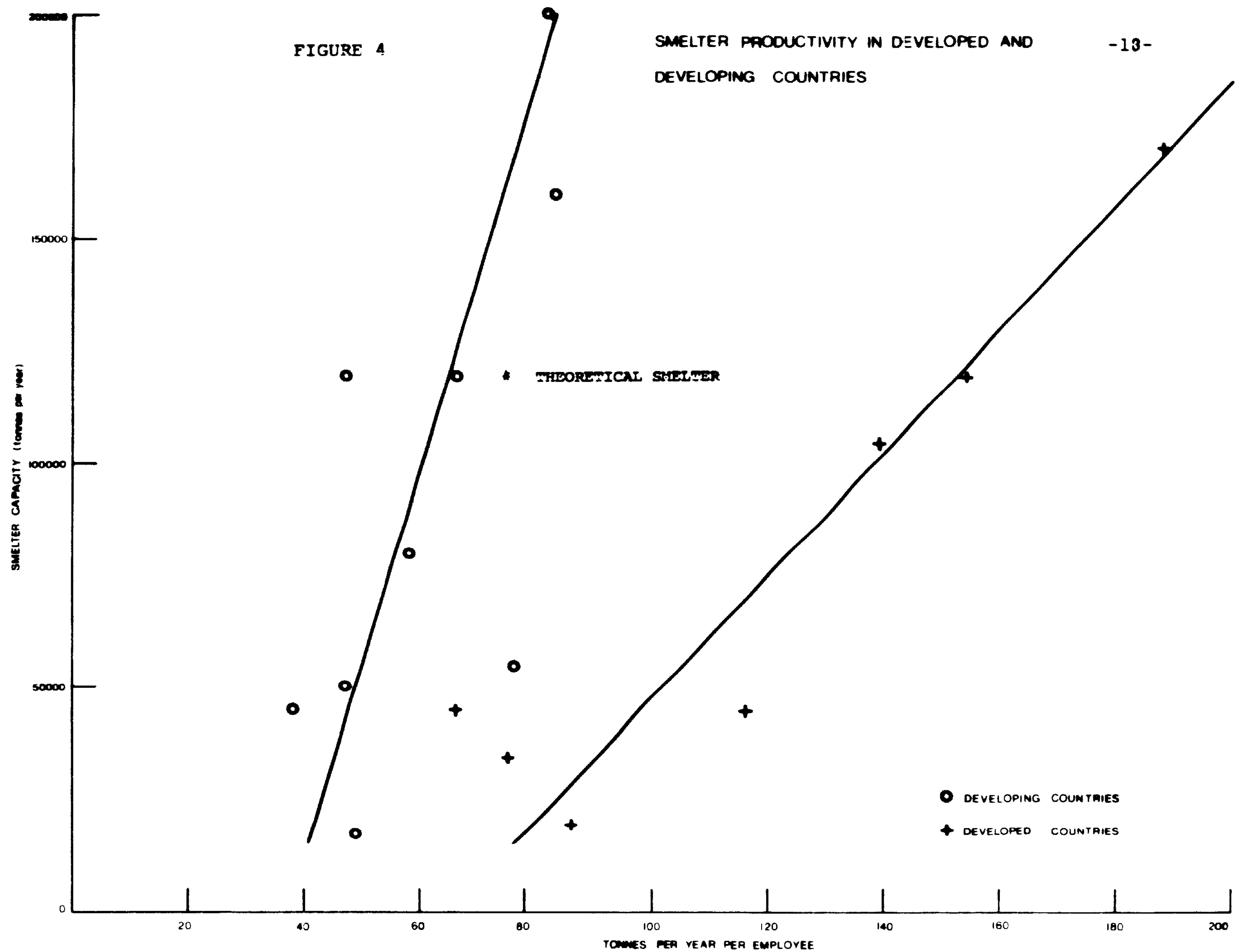
A very rough measure of overall labour efficiency can be obtained by dividing the annual production by the number of employees.[1] The result is the number of tonnes of metal produced per year per person employed, including employees of all categories and plant sections. The "efficiencies" thus obtained, unfortunately, represent different things for different plants and hence are not strictly comparable. Indeed, they mask real differences among plants which have nothing to do with efficiency, and in general will make plants in developing countries look less efficient by comparison than they really are. The reason for this is that plants in developing countries generally have more self-sufficient maintenance shops, they run housing facilities, often also hospitals and schools, and all the personnel involved in these "extra" activities make the metal production per man lower than that in developed countries, without the workers themselves being necessarily less efficient (also see Section 2.2).

Whatever the reasons, more employees are necessary in developing countries, and this fact is clearly shown in Fig. 4. The figure contains too few points for the results to be really

[1] Another form of expressing the efficiency is in numbers of hours of labour per tonne. In such cases, it must be specified whether people involved in maintenance, management, sales, etc. are included.

FIGURE 4

SMELTER PRODUCTIVITY IN DEVELOPED AND DEVELOPING COUNTRIES



conclusive, but it is unlikely that such a clear trend as that shown by the figure would not be supported by data from more smelters. There are some interesting conclusions that can be drawn from Fig. 4. One is that labour costs per tonne do not decrease with size in developing countries nearly as rapidly as they do in developed countries. This is a fact to keep in mind when one talks about economies of scale. Another is that as smelters in developing countries become "mature," say after a minimum of five years operating at full capacity, their outputs per man begin to increase. The oldest smelter in a developing country in the figure (well over ten years of operation) is the one of 55000 tonnes capacity and 76 tonnes per employee, which mixes with those in developed countries. For other smelters in the figure, historical data show that they have moved, albeit sometimes unsteadily, towards higher efficiencies.

Unfortunately, the data are not sufficiently detailed to allow a productivity analysis by job, but it does permit some analysis of the situation in the potrooms and casting. Plots of the numbers available are shown in Figures 5 and 6. In the case of the potrooms the figure shows that smelters in developing countries employ about twice as many people than those in developed countries; in casting the developing countries do better, probably because their product mixes are simpler. In the potrooms, a combination of factors-- less automation, less experience, poorer management at the lower levels--result in the need for more personnel.

FIGURE 5

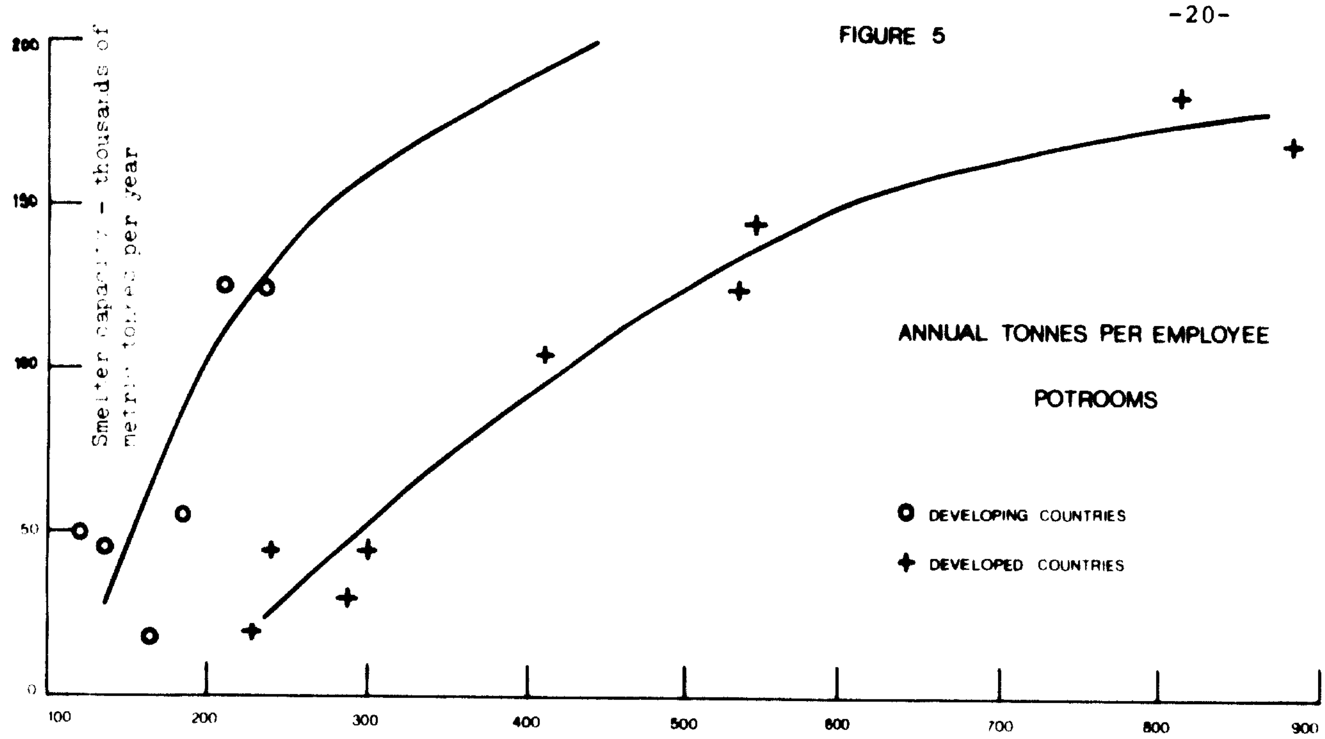
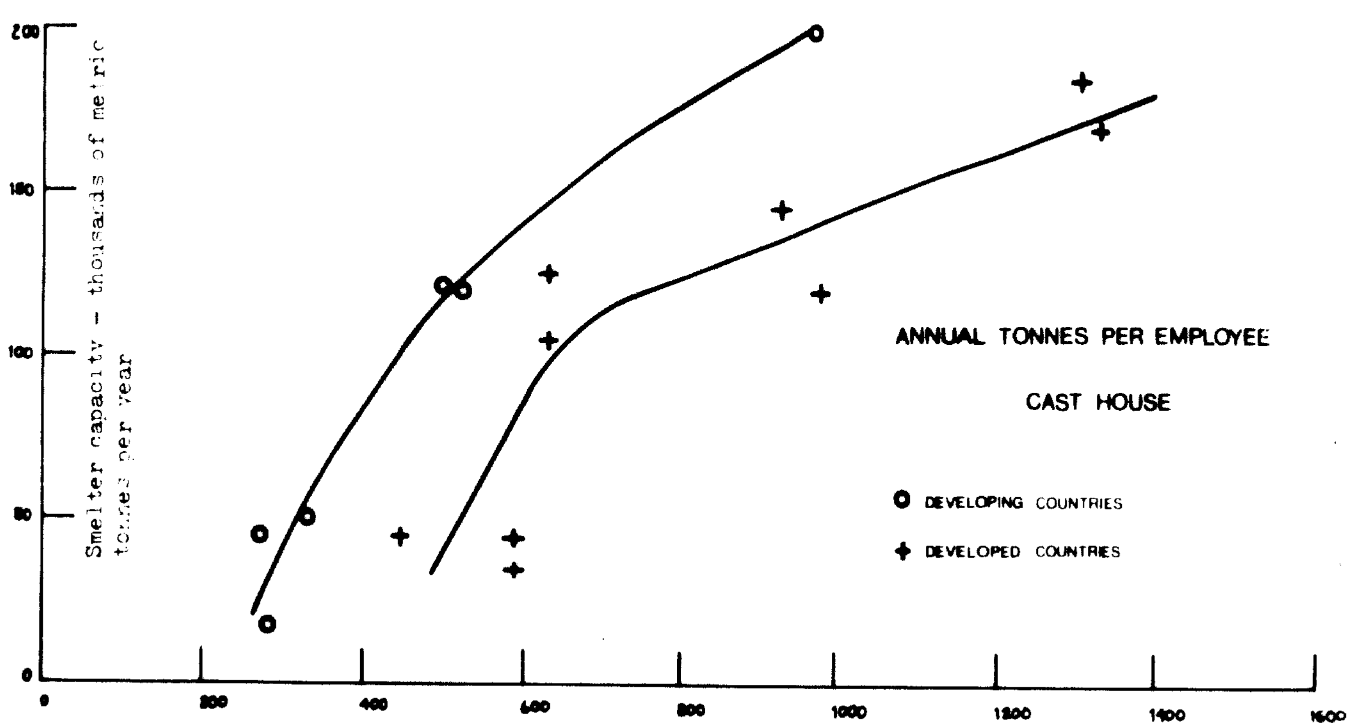


FIGURE 6



The lower output of metal per employee conspires against the competitiveness of the smelters in developing countries. After the cost of housing, medical care, schooling, transportation, and other services is examined, the subject of the cost of labour in smelters in developing countries will be discussed to see whether the often mentioned competitive advantage of lower wages in developing countries is real, or rather one of those myths that perpetuate themselves because they are never analyzed critically.

One final point that is worth analyzing under the heading of productivity is the breakdown of employees into hourly paid and salaried. For seven smelters in developing countries, the proportion of hourly workers varies between 70.4% and 88.7%, with a weighted average of 79.0%, and for nine smelters in developed countries the range is 66.2% to 83.5%, with a weighted average of 74.8%. These numbers indicate an excess of hourly workers in developing countries or, put differently, we find that the lower productivity which is shown, for example, by Fig. 4, is more accentuated when we focus on the hourly workers. This means that the lower output of metal per employee is not due to large administrative bureaucracies that one may expect at least in some developing countries, but to the need to use more direct and maintenance labour. This need, in turn, most probably arises from the lack of sufficient training of the workers themselves and their supervisors.

B. Organization Charts

There are probably not two smelters in the world with the same physical layout. The same is likely to be true of their organization charts.

As an answer to the Questionnaire distributed among the aluminium companies, detailed organization charts were received for fifteen smelters in thirteen countries, belonging to--or controlled by--nine different owners. All fifteen charts are different, but since more or less the same functions have to be performed in all smelters, certain regular patterns emerge on the basis for which the chart described in Section 2.2 was prepared.

For the purposes of illustration two of the charts received are included in this report (Appendix 2 & 3). One belongs to a smelter in an industrialized country, the other to one in a developing country. The two smelters, however, are roughly of the same capacity (in both cases larger than the capacity chosen in Section 2.1), and use roughly the same technology (high amperage cells, prebaked anodes, North American origin), but belong to different owners. The differences between the charts are definitely due more to management decisions and geographical locations, rather than to differences in technology. For example, in the developing country, the organization chart shows two positions that do not appear in the other chart, namely, a School Principal and a Resident Manager (essentially in charge of the relations with the host country), at the highest managerial level, together with the Works and the Administrative Managers. At the same level they place also the Chief Medical Officer, a position that in developed countries would appear at least one stage, maybe two, below.

The rest of the charts offer very few other substantive differences. For instance, the smelter in the developed country has a Major Projects Administration and a Director of Environmental Control which have no counterpart in the other smelter, and the opposite occurs with sections such as Recreation and Laundry.

The similarity in the substance of the organization charts was to be expected, since the activities of the two plants and the basic technologies are the same. The chart presented in the next chapter is, to a large extent, a combination of the two presented here.

One final point that is worth mentioning refers to the composition of the work force. One of the major aluminum producers, with smelters in many countries in different stages of development, provided the following average percentages over all its smelters:

Engineering & Technical Personnel (university graduates)	3%
Technicians (non-university graduates)	2%
Supervisory	5%
Maintenance Workers	20%
Production Workers	50%
Administrative and Sales	20%

In developing countries, the percentage of professionals and production workers tends to be a bit higher, and that of administration and sales somewhat lower.

C. Use of Computers

Twelve aluminum companies answered point I.6 of the Questionnaire relative to the use of computers, providing information on a total of twenty three smelters in seventeen countries (ten of which are located in nine developing countries). The range of computer utilization goes from none at all to very highly sophisticated systems. There are also cases where some operations are automatically controlled but without the use of computers (e.g., by means of analog systems).

Of the twenty three smelters on which data are available, four have no system of automatic control, although two of them said they were in the process of implementation of a system. All other smelters had at least a program for automatic resistance control, capable also of coping with unstable pots (called "noisy" or "sick"), and some control over anode effects. In five cases the program for anode effects simply identified the effect, announcing it by means of a sound or visual signal, and registering the duration and maximum voltage on paper. In the other cases, the computer was programmed to move the anodes in a manner that would quench the effect. Eight plants report using computer controlled crust breaking and feeding, totally automatic. In one smelter the computer announces which pots have to be broken and fed at given times by writing their identification numbers on a teletyper located in the potline supervisor's office.

Automatic control, that was limited mostly to analog systems and used by very few smelters only ten years ago, has become a standard feature in potrooms. Computers are also used in substations, warehouses, and in several administrative functions. Only one smelter reports having computerized the activities in the carbon plant, although most carbon plants have automation of some kind. Little, if any, digital automation has been introduced in casting.

D. Expatriates

This subject, of course, mostly concerns developing countries. The number of expatriates and the duration of their stay at the plant varies over an extremely wide range, from essentially zero to about one third of the total number of employees. One of the factors that affects the presence of expatriates is ownership; if the smelter belongs to a transnational corporation, it is practically certain that a few expatriates, from the country of origin of the corporation, will always stay. The other factor is the host country's capacity to provide the necessary personnel.

With regard to the latter point it should be remarked that expatriates may be hired at all levels, professional, supervisory, skilled workers and common factory laborers. The first three groups mentioned tend to be in short supply in developing countries, while the fourth group may be required in both developed and developing countries.

Expatriate professional and supervisory personnel from the technology supplier will always be present during the start up of a new plant, even if the plant is in a developed country. The number will vary but a basic team of about twenty people is unavoidable.

The start process is slow, particularly if green personnel have to be trained simultaneously. A total of 352 pots can be started in one year, but the managers of a new facility in a developing country should not get impatient if the program is stretched out to at least eighteen months (five pots per week) or more likely to two years. During this period some expatriates from the technology supplier can be expected to stay.

With regard to foreign workers, the situation will be dictated by the local labour market, and no general statements are possible.

E. Absenteeism and Personnel Rotation

Detailed information was provided by several companies, in particular, with regard to smelters in developing countries. Again, it is difficult to make general statements because of very great differences from one smelter to another.

With regard to absenteeism, it ranges from slightly below 5% to about 12%. The pattern of absenteeism by Division seems to be fairly constant from plant to plant. It is higher in Production than in other divisions, and within Production it is highest in Potrooms. This is a fact that has to be kept in mind when making manning estimates: potrooms may require twice as many relief workers than casting or maintenance, for example. Below are the figures for one smelter visited, normalized so that the average absenteeism for the whole plant is given the value one. Figures below one mean, then, low relative absenteeism and vice versa.

Average for Production:	1.06
Potrooms:	2.03
Carbon Plant:	1.25
Cast House:	1.07
Production Services:	1.57
Average for Maintenance:	0.99
Mechanical Maintenance:	1.29
Electrical Maintenance:	0.79
Average for the Rest of the Plant:	0.52

Turn-over showed enormous discrepancies among plants, but there is good correlation between turn-over figures and percentage of non-local workers, where by non-local it is meant anybody who had to move from his habitual domicile in order to work at the plant, even if the move is from the next village.

Where workers are not strictly local, where a company town was built, where many of the workers are young and single, or married but left the families behind, where the location of the plant is not sufficiently attractive or conditions not favorable for the permanent settlement of newcomers, turn-over is very high, exceeding 40% per year. Since such turn-over rates are extremely costly and disruptive, the conditions that caused them should be taken into account when selecting a site. While visiting a smelter I asked a superintendent how long he had been with the company; his answer was: "Oh, very long, I'm the most senior superintendent at the plant. I've been here three years," and he added, "and I may stick it out here two more before I go home." That plant has one of the lowest output of metal per employee in the world for that size of smelter.

F. Medical Care and Safety

In general, medical services in smelters located in developing countries are more extensive than is average in industrialized countries. Often they cover not only the worker but also his immediate family, and a hospital outside the plant has to be set up to provide the required services. This depends very much, of course, on local conditions.

In most developing-country smelters the safety records are very good, but on the average not as good as they should be. In some smelters proper clothing and safety equipment (hard hats, goggles, etc.) are not provided and standards of cleanliness of both plant and men leave much to be desired. This, however, is not the rule. Most technology suppliers include safety instruction in their services but in several cases it is obvious that not enough was done.

G. Housing, Schools and Other Facilities

In five of the six smelters visited, extensive housing developments had been undertaken by the companies, and in the sixth a program to provide housing to the personnel was being launched. The same is true of practically all the other smelters in developing countries, the few exceptions are plants that were built in, or next to, large cities with existing industries.

Most smelters in developing countries also have some kind of recreational facilities, such as a sports field, an auditorium, etc. Depending on the local situation, the smelter may also find it necessary to run a school, a commissary, a public transportation system, etc.

H. Cost of Labour Per Tonne of Metal Produced

The determination of this number was not one of the aims of the present Report, but the information that was obtained over the past months makes it possible to reach some general conclusions.

In a study prepared by the Council of Wage and Price Stability of the U.S.A. in early 1978, the total cost of labour to the producer was computed to be $12.00 per hour, and the average number of hours per tonne of metal required was taken to be 13.45, giving a total labour cost of $161.40 per tonne of metal (about 7 1/3 cents per pound). Of the total of $12.00 per hour, the employee received about $9.00, and the rest are fringe benefits, etc.

In none of the developing countries, the pay received by the worker comes near the figure of $9.00 per hour, but in some the additional cost of the worker to the company is far more than the 33% which is the average in the U.S., so that the figure of $12.00 per hour total cost begins to be approached. Let us assume that a worker gets $3.00 per hour, in a country where direct fringe benefits (social security, medical insurance, etc.) amount to 60%. In addition he gets a house: the cost to the company could easily be another 50% of the man's wages. The worker also gets one free meal per day, free transportation to and from the smelter, free medical services for himself and his family, free use of recreational facilities. These items may add another 20%. Then the total cost of the man to the company is $6.90 per hour. If twice as many man hours per tonne of metal are required, labour costs turn out to be higher than in the U.S., even though the man is paid three times less.

Figure 4 indicates that for a smelter of about 125000 tonnes per year capacity, the number of hours per tonne may be as much as two and a half times greater in developing countries. If this number is accepted, it means that labour costs in developing countries will be the same as in industrialized countries if the cost of labour to the producer is $4.80 per hour; if all fringe benefits represent about 100% of the wages--a very likely situation--the worker cannot receive more than $2.40 per hour (it is true that he receives housing and other benefits). This would be about one fourth of the U.S. rate, without any advantage to the company.

In other words, wages have to be very low by developed country standards for the smelter to have a competitive advantage as regards labour costs. The alternative, of course, is to narrow the efficiency gap by means of more training and better management.

However, greater efficiency means that less jobs are created. For some developing countries this would be a hard choice to make. But if job creation is one of the main purposes in building the smelter, the country should reconsider whether aluminium smelting is the right investment choice, since it is not a labour intensive industry.

Chapter 2 - EDUCATION AND EXPERIENCE QUALIFICATIONS FOR THE STAFF OF ALUMINIUM SMELTERS

Section 2.1 General Description of a Hypothetical Smelter Selected for the Present Study

There is no such thing, of course, as a "typical modern smelter." All smelters, however, use the Hall-Heroult process; there seems to be a general consensus that for capacities exceeding 100,000 MTPY prebaked anodes are more advantageous than Soderberg; the techology of rectifiers is such that lines containing well over 200 cells can be built; the magnetohydrodynamic instabilities and other problems created by current intensities around 150kA have been essentially solved. These facts make it possible to define, if not a typical smelter, at least a reasonable smelter that could be designed today for construction in a developing country (nor is there a "typical developing country"). The choice of parameters made for the present study is arbitrary and practically any one of the values could be changed by several percent. However, it was decided to choose one well-determined set; otherwise, it would have been necessary to give for each parameter a possible range of values, or for some operations (like breaking and feeding of the cells) alternative technical solutions, and the end result would have been a very muddled report. Therefore, personnel requirements will be based on the smelter whose description follows. Where appropriate and possible, technical alternatives will be pointed out together with their consequences on personnel requirements.

The "reasonable" smelter is of the pre-baked type and has a rated capacity of 120,000 MTPY. It consists of two potlines of 176 pots each--each line occupying two buildings (i.e., 88 pots per building). The current intensity is 140 kA and the daily production is 955 kilos per pot. To satisfy the rated capacity an average of 344 pots must be in production (i.e., two pots per building are assumed to be undergoing relining at all times).

Before going into a further description of the smelter, I would like to justify the numbers given so far, and for that purpose I will refer to the premises stated at the beginning of this Section.

In the Terms of Reference prepared by UNIDO, a capacity greater or equal to 70,000 MTPY is mentioned. To be safely above that grey area where the economics of pre-baked versus Soderberg smelters are comparable, I decided to choose a capacity of no less than 120,000 MTPY. On the other hand, I wanted to keep the investment and the general scope of the project at a reasonable size, simply because most developing countries have no experience in managing very large industrial projects (both technically and commercially) and also because of the increasing difficulty in raising the necessary financial resources as the investment increases.

The chosen capacity essentially imposes the need of two potlines. I realize that there exist pots today capable of producing between 1600 and 1650 kilos per day, and that one potline with about 210 of these pots would reach a production of

120,000 MTPY, but for a developing country I thought it more appropriate to choose a relatively low current intensity and relatively short potlines. Maybe the assumption of a current intensity of 140 kA is too conservative; if 150/160 kA had been chosen we could still maintain the same number of pots distributed in the same manner, with a higher production of metal, without increasing personnel requirements in the pot rooms. However, I would be more reluctant to accept longer potlines, which are more difficult to handle.

The next technical choice is between side break and center break pots. The trend is towards center break, fully controlled by computer, with the pots arranged side by side. I have chosen, however, an arrangement of pots end-to-end, with the feeding and breaking operations done from mobile equipment running along the long sides of the pots simply because it is the choice that requires more labour. If computer controlled, center break pots are used, the 48 mobile equipment operators (see page 62) are eliminated, as well as about ten automotive mechanics. On the other hand, the central computer would have to perform some additional operations to those listed on page 36. Each building is divided into two sections by a central corridor that joins the four buildings. The 88 pots in each building are arranged in two lines of end-to-end pots, and hence there are 44 pots on each side of the central corridor. Each building has two overhead cranes for anode changing and tapping operations (a spare crane normally sitting at one end of the potrooms can be brought in if there is need). We will further assume that the pots are hooded and the potrooms fitted with exhaust pipes to take the fumes out of the buildings. The working floor is about 3 meters above ground and has grilles both in the center and along the outer sides of the pots to provide good convective ventilation (say, about 20 air changes per hour) and quick motion of the fumes towards the roof when the hoods of the pots are opened. No recovery system on the roof is contemplated, i.e., the fumes are allowed to flow into the atmosphere. About 90% of the fumes, however, are assumed to be captured by the hoods and taken out of the building. When manning is discussed, we shall find it convenient to be able to identify the different parts of the potlines. We shall refer to the two lines as Series A and Series B. We will say that Series A is housed in buildings 1 and 2, and Series B in buildings 3 and 4. Each building will have a "Northern" half and a "Southern" half. Therefore, if we say "crane Operator of 2N", we refer to the man who operates the overhead crane that serves the 44 pots of the Northern half of building 2, and we know that these pots belong to Series A.

As already mentioned, alumina feeding and crust breaking are done from mobile equipment. The alumina feeders of one given series are loaded at a silo located over the central corridor, between the two buildings that house the series in question. These silos, of about 500 tons capacity each (three days' supply) are connected to the main alumina storage at the pier (or to the dry scrubbers if such facilities are installed).

To complete this brief description of the pot rooms, we shall mention two more things. The first one regards pot relining. We shall assume that it is done in situ. The second regards computer applications. We shall assume that all pots are connected to a central computer that can perform the following operations: 1) adjust the value of the resistance to a target set by the operator; 2) detect unstable pots and attempt to remove the instability by changing the target resistance; 3) give warning of the occurrence of an anode effect (but no action to quench it is taken by the computer).

The rest of the plant does not require such detailed description. Let us first consider the carbon plant. The petroleum coke is stored in silos by the pier, while the coal tar pitch and butts are stored near the paste plant. Milling operations are conventional and the paste is prepared in a battery of six batch mixers (which could be replaced by two continuous mixers in tandem without affecting personnel requirements significantly; in either case mixing is not a labor intensive operation). The anodes are formed in a vibrating machine and stored in a building that also houses baked and rodded anodes. From milling to forming, the green plant equipment is of a size sufficient to produce all the anodes required by the smelter in 15 shifts per week.

The baking is done in two ring furnaces of the proper size. The rodding (by "rodding" I mean all operations from removal of the old butts to the actual rodding of the new anodes) is a conventional installation, where we assume that the anode is joined to the rod with cast iron produced in an induction furnace, and that the assembly is aluminized before being sent to the potrooms. Rodding is also supposed to operate just 15 shifts per week.

The casting facilities are perhaps the most difficult to define because they depend strongly on the type of market the smelter is supposed to satisfy. I decided to adopt a very versatile configuration that could be excessive under certain circumstances. The cast house is supposed to have three fixed holding furnaces, six tilting casting furnaces, two D-C semi-continuous vertical casters, one facility for casting 20 kg-ingot, one continuous caster (it could be a Properzi-type machine for wire, or a horizontal caster for plate or sheet), one slab saw, one billet saw, one homogenizing oven, and facilities for stocking, palletizing and loading the finished products into trucks or trailers.

The plant will include a laboratory to analyze the incoming raw materials, materials in process and finished products, including modern spectrographic equipment. It must also be capable of analyzing samples of air, vegetation and animal life to measure the level of fluorine absorption.

Maintenance facilities are very important in any smelter, but especially so in a smelter located in a developing country. The maintenance area of the plant is where the greatest conceptual and quantitative differences exist between smelters located in different industrial environments. In other words, if one takes the blueprints of a smelter built in North America, Japan or the more industrialized countries of Europe, and wishes to use them as the basis for the design of a similar smelter in one of the lesser developed countries, most of the equipment and facilities in the potrooms, carbon plant and cast house, i.e., in the production departments, could remain largely unchanged. On the other hand, the maintenance shop requires a much more thorough adaptation to local conditions. No general guidelines can be set here since the situation of each smelter is a case by itself. However, we can say that in a developing country smelters can be expected to do a larger share of maintenance work in-house, compared to smelters in industrialized areas. They may have to rewind electric motors and transformers, overhaul diesel engines, manufacture some spare parts and simple pieces of equipment, and perform a number of other jobs that would be contracted out in the more developed countries. In view of the above, a largely self-sufficient maintenance division is contemplated, involving very well equipped mechanical, electrical, instrument and vehicle shops. Unquestionably, the division presents also the most difficult problem in manning.

It is assumed that the plant is built adjacent to the ocean or to a deep river, and that it operates its own pier, capable of berthing at least medium size (about 20/30000 tons gross weight) bulk carriers. The pier will have equipment capable of unloading about 10000 tons of alumina per day, and a belt to carry the bulk products (alumina and petroleum coke) to nearby silos, two for each product, giving total storage capacity of 60 days. Pitch, cryolite, aluminum fluoride, alloying materials, refractory bricks, etc. will also be received at this pier, and at least part of the metal produced will be shipped from this facility.

One basic assumption regarding our smelter is that it will not generate its own power. Further, I will assume that power will be purchased at a fairly low voltage so that it can be fed directly into the transformer-rectifier system; hence, the main substation, if it exists, is not the responsibility of the plant. Each series has its own battery of silicon rectifiers with sufficient spare capacity.

The rest of the plant--roads, utilities distribution, offices, locker rooms, cafeterias, medical services, etc.--are conventional and it is unnecessary to include them in this description. As a general rule I would say that the smelter should try to own as much land around it as possible, for reasons of mutual pollution (if surrounded by agricultural or grazing land, the eventual polluter would be the smelter, but in the midst of an industrial park, other plants could be polluters to the smelter). According to this principle, I would consider it advisable to reserve for the smelter a site of not less than 200 hectares. However, a 120000 TPY smelter could be squeezed into a site about one third that size if local conditions of land availability make it imperative.

Section 2.2 <u>Organization Charts for the Smelter Described in 2.1</u>

In the previous Section the remark was made that the choice of parameters describing a "typical" smelter was necessarily arbitrary, since the range of "reasonable" parameters is fairly wide. A similar remark is required here. Even for a perfectly well defined smelter there is considerable latitude in the choice of possible organization charts. First of all, the same function may be performed in different smelters under the responsibility of different people. For example, in Table 5 at the end of the chapter the function of relining pots is the responsibility of the Production Services Superintendent (who, in turn, reports to the Production Manager). Equally well, pot relining could be the responsibility of the Potroom Superintendent, or it could be removed from the Production area altogether and be placed as one of the functions to be performed by the area of maintenance. As a matter of fact, the entire production Services Department could be eliminated and its functions performed by either Production, or Maintenance, or be shared by both.

One fairly unorthodox Division appearing in the chart is Development and Engineering. Extremely few plants in the world do development (such activity would normally be carried out in a Research & Development Division serving the whole corporation) and engineering activities would most likely take place in either the maintenance or the technical divisions.

It could also be argued that Traffic is not an activity that deserves the rank of division, and that it could very well be a department reporting to the Administrative Manager.

Many of these changes in emphasis and location of certain activities can be made without affecting the smooth operation of the smelter. Sometimes one has to accomodate to local habits, or has to accept what is traditional with the supplier of the technology, or even has to bow to problems of personalities. On the other hand, some of the features in the organization chart presented here are not arbitrary and require justification.

The overall justification is that the chart applies to a smelter in a developing country which, it is further assumed, is locally owned by a company--either public or private, it does not matter--that does not own any other smelter. Those two conditions make it necessary to include more people in the chart than would be the case either in: a) an industrialized country where trained people for practically any job can be found, or b) a smelter owned by a large corporation that has the possibility to switch critical personnel from another smelter if an emergency arises.

The position of Works Manager, for example, could be eliminated, and certainly the Development Division would also disappear in situations a) or b) of the previous paragraph. Also a fairly high percentage of supervisory personnel, and a somewhat lower percentage of hourly workers, could be eliminated in those situations. In an independent smelter in a developing country these extra positions have to be filled, not because the people are lazier, or more ignorant or less efficient, but simply because of the greater difficulty in finding and training replacements, and also in obtaining reinforcements to cope with emergency situations.

In view of the above, the total number of employees proposed for the theoretical smelter is 1625. In a highly industrialized country, a 120000 tonnes per year smelter can be operated with about half that number of workers. If we refer back to Fig. 4, however, we see that our smelter falls among the less labour intensive ones in developing countries. I think it would be unrealistic to base this report on assumptions that deviate sharply from current employment figures in existing plants.

Section 2.3 Job Descriptions

a) Introduction

A personnel department preparing job descriptions in a real aluminium smelter in a developing country should, in my opinion, spell out each job in very great detail so that no questions are left in the workers' minds. For example, in the job description of a painter it should be explicitly stated whether he is or is not supposed to carry his ladder, paint cans and brushes; whether he has to clean or not clean the place after painting, and/or his own brushes, and if the painter will, in certain circumstances, be provided with a helper. If such is the case, then job descriptions must state exactly what divison of labour there will be between painter and helper. If a firm is going to train farmers, or fishermen, or sheep grazers to be production or maintenance workers in a smelter, job descriptions must tell the man what to do in the minutest detail, since there is no industrial tradition to fall back on. Common law or jurisprudence will not work; the personnel department will have to produce its own exhaustive Napoleonic codes.

It is beyond the scope of this report to produce such detailed job descriptions. Furthermore, it probably would not be possible to produce a set of descriptions that could apply universally to all developing countries. Therefore, the descriptions presented in this Section are brief indications of the general character of the job. These will be useful to give the people responsible for a feasibility study of a smelter: 1) a clear picture of the quality and quantity of the personnel that will be required; 2) guidelines to perform a survey of the local labour market; 3) guidelines to prepare the definitive job descriptions.

Finally, I wish to make one more comment before going into the descriptions themselves. Some jobs, particularly in accounting, purchasing, industrial relations, and also some in maintenance, are not peculiar to aluminium smelters and, therefore, they are mentioned for the sake of completeness but no description is provided.

b) Descriptions

I - Salaried Personnel

Ia - Managerial Level

Plant General Manager - He provides the link between corporate headquarters and the plant and is responsible for the overall operation of the smelter. He organizes, directs and controls all plant operations including manufacturing plans, long range supply of raw materials and spares, human resources policies, relations with the local community, environmental problems inside and outside the smelter, shipment of the finished product, research and development activities--all of the preceuing based on overall policies and general objectives of the smelter company. He is ultimately ressponsible for a work force in excess of 1600 persons.

Works Manager - He must be able to act as Deputy General Manager, and is directly responsible for the production of metal, according to the requirements of the Sales Division, for product quality and environmental control, and for the maintenance of plant and equipment. He can propose technical changes and eventually supervise the implementation of changes. He has three major Divisions of the plant reporting to him with a total labour force of about 1370.

Production Manager - He organizes, directs and controls the activities of his Division according to general directives from the Works Manager. He has carbon plant, potlines, casting, and production services under his direction totalling about 750 persons.

Maintenance Manager - He organizes, directs and controls the activities of the Maintenance Division according to general directives from the Works Manager. The maintenance function covers mechanical and electrical repairs done both in situ or in the shops, the upkeep of utilities, services, buildings, grounds and dock, repair and servicing of all mobile equipment, all in accordance with accepted engineering practices. The primary objectives are to ensure continuous operation of the plant and through the power section a continuous supply of electricity to the plant. These objectives are carried out through a work force of about 470 persons, including a large proportion of highly skilled workers.

Technical Manager - He organizes, directs and controls the activities of the Technical Division according to the general directives of the Works Manager and the quality requirements of the Sales Division. The division is responsible for the supervision of technical operating parameters in anode production, potrooms and casting, quality control procedures of the final products, and environmental controls inside and outside the plant. The Division includes the Chemical, Spectrographic and Environmental Control Laboratories. The staff numbers close to 50 persons, many of them university graduates and technicians.

Traffic Manager - He organizes, directs and controls the activities of his Division according to general directives from the Works Manager and in coordination with the Purchasing Department and the Sales Division. His Division is responsible for the transportation of everything that is bought and sold by the plant--in particular, for the operation of the port facilities and rail terminal, and for trucking operations. To perform these functions, the Division maintains a work force of about 100 persons.

Manager of Development and Engineering - He organizes, directs and controls the activities of the Development and Engineering Division and reports directly to the General Manager. Before the plant is built, he is responsible for the technical aspects of the feasibility study, participates in the negotiation of the technology with the chosen supplier and then becomes the link between the technology supplier and the plant. After start up his Division has a development function consisting of maintaining technical contacts between the outside world and the plant, the preparation of feasibility studies for new ventures (expansions, major technical changes, new corporate activities such as forward or backward integration), the training of skilled personnel for new projects. The engineering function covers improvements in existing equipment, design and supervision of construction and installation of new pieces of equipment and facilities, and eventually the design and supervision of plant expansions. These functions are accomplished by a team of about 50, many of them university graduates.

Industrial Relations Manager and Administrative Manager - Their functions are similar to those of their colleagues in other industrial installations of similar size, and hence do not need special descriptions. Similarly, I shall omit describing other jobs in these two Divisions since their responsibilities are not peculiar to the aluminium industry.

Ib - Senior Supervisory Level

Reduction Superintendent - He organizes, directs and controls the activities of the Reduction Department according to general directives of the Production Manager. The large labour force involves considerable administrative work, and close cooperation with the Industrial Relations Division. Attention to the regulation and to the training of personnel in operating the potlines in a safe manner on a continuous basis constitutes a major work component. He directs staff and through liaison with other departments ensures that essential raw materials and supplies are available in suitable quality and quantity for aluminium production. He is responsible for a work force of about 270 persons, of which 30 are supervisors, foremen and clerks.

Carbon Plant Superintendent - He organizes, directs and controls the activities of the Carbon plant according to general directives of the Production Manager. He plans and coordinates the work effort in producing good quality prebaked anodes through all operations from grinding, through mixing, forming, baking to rodding. He directs a work force of about 170 persons, with some operations performed on a continuous basis.

Cast House Superintendent - He organizes, directs and controls the activities of the Cast House according to general directives of the Production Manager. The casting facilities include a variety of equipment for the alloying and casting of ingot, DC products and rod or strip, followed by sawing, heat treating and shipping. He cooperates with the Technical Division to ensure proper quality control of products to meet required metallurgical standards. He must also maintain a close liaison with the Sales Division. He directs a work force of about 160 persons, including professionals, foremen, clerks and hourly workers.

Production Services Superintendent - He organizes, directs and controls the activities of his Department according to general directives of the Production Manager. He is responsible for relining pots, cleaning and replacing the lining of all vessels that carry liquid metal, and maintaining the fume exhaust system, including the hooding of the pots (if the smelter has dry scrubbers his responsibilities would include changing filters and routine maintenance of the facilities). He operates in constant coordination with the Potrooms and Casting Superintendents. He directs a work force of about 100 persons (130 if the plant is fitted with dry scrubbers).

Mechanical Maintenance Superintendent - He organizes, directs and controls the activities of the Mechanical Maintenance Department according to general directives of the Maintenance Manager. He is responsible for keeping all mechanical equipment, including that at the wharf (as well as those which are the responsibility of the Production Services Department), in proper running condition; for maintaining a proper supply of spare parts; for the provision of all service utilities to the plant except electricity (e.g., water, compressed air); for the preparation and execution of a program of preventive maintenance, for the dismounting and removal of obsolete equipment; for the installation of new pieces of equipment and plant expansions as long as an outside contractor is not called in. To perform his duties, he has a work force of 215, including engineers, foremen, and many skilled tradesmen.

Electrical Maintenance Superintendent - He organizes, directs and controls the activities of the Electrical Maintenance Department according to general directives of the Maintenance Manager. He is responsible for the interface with the power company, for the AC distribution to the plant, for the transformer-rectifier system feeding the potlines, for the operation of disconnecting and reconnecting pots to the lines, for the servicing of all transformers, electric motors and switching gear in the plant, for the servicing of all electric and electronic instruments, for the servicing of the computers and computer controls. To perform his duties he has a work force of 165, including engineers, foremen, and many skilled tradesmen.

Buildings and Grounds Maintenance Superintendent - He organizes, directs and controls the activities of the Buildings and Grounds Maintenance Department according to general directives of the Maintenance Manager. He is responsible for keeping in good repair the buildings, roads, fences and any other kind of civil construction (e.g., silos, water tanks, cooling towers, pier, etc.) belonging to the plant. If the plant owns housing, schools, medical centers, sport facilities, etc., the maintenance of these premises would also be included among his responsibilities. If no housing is involved, he directs a work force of 85 people, including engineers, architects, foremen, and many skilled tradesmen.

Laboratory Superintendent - He organizes, directs and controls the activities of the Laboratory according to general directives of the Technical Manager. He is responsible for the optimal use of analytical techniques aimed at improving production processes and final products. He directs a chemical and spectographic laboratory which carries out routine and non-routine analysis of incoming raw materials, materials in process, and final products. The laboratory is also responsible for all analytical work related to internal and external environmental control. He directs a staff of 20, including chemists and technicians.

Environmental Control Superintendent - He directs, organizes and controls the activities of the Environmental Control Department according to the general directives of the Technical Manager. He is responsible for gathering information on pollution standards and legislation for both factory workers and for the outside environment, techniques to measure pollution levels and on abatement technology. He has to interact with union and community representatives on the subject of environmental control. He has to devise and supervise a program of collection of samples of air, water and flora inside and outside the plant, and fauna outside the plant to be analyzed at the laboratory for fluorine content and other pollutants, He has to coordinate a program of urine analysis of plant personnel with Medical Services. He supervises a staff of 16, mostly technicians in charge of sampling.

Chief Metallurgist - He directs, organizes and controls the activities of the Metallurgical Department according to the general directives of the Technical Manager, and in close coordination with the Sales Division. He is responsible for the specifications, production procedures and quality control of alloys produced in the plant. He is also responsible for technical reports and general assistance to buyers of metal in the areas of alloy uses, finishing, fabrication, etc.

Development Superintendent - He supervises a small staff of highly qualified technologists (scientists and engineers) whose function is to keep up to date on technological improvements in aluminium smelting in particular, and in the aluminium industry in general, including the production of raw and alloying materials, new uses of aluminium, new equipment, raw materials substitution, etc. He directs a staff of ten.

Engineering Superintendent - He organizes, directs and controls the activities of the Engineering Department according to general directives of the Manager of Development and Engineering. He is responsible for the engineering evaluation of projects involving the modification, elimination, expansion or replacement of existing facilities, and for the detailed engineering and execution supervision of the approved projects.

Other Senior Supervisory Positions are common to other industries and hence do not require description. They are:

Port Operations Superintendent
General Traffic Superintendent
Warehouses Superintendent
Personnel Superintendent
Training Superintendent
Medical Services Chief Physician
Safety and Security Superintendent
Public Relations
Chief Controller
Purchasing Superintendent
. General Accountant

Ic - Supervisory, Intermediate and Lower Levels

Potline Supervisor (2)* - He directs and supervises the facilities and employees of one potline according to the general directives of the Potroom Superintendent. He is responsible for the continuous operation

* A number in parenthesis after the title indicates how many positions of this kind there are in the plant.

of the potline. He supervises the foremen and performs the various operational personnel and administrative functions pertaining to the job for the electrolytic reduction of alumina to aluminium. He would be actively involved in the on-the-job training of personnel. He directs a work force of two clerks, twelve foremen and about 120 hourly workers.

Green Anodes Supervisor - He directs and supervises the facilities and employees of the green anode plant according to the general directives of the Carbon Plant Superintendent. These facilities include: the storage of anode raw materials (petroleum coke, pitch and butts of used anodes); the milling of raw materials and their feeding into the mixers; the dosification and feeding of anode paste to the vibrator; the cooling of green anodes. The facilities are to a large extent automated and hence his work force is relatively small, numbering in total 36 persons. The facility operates five days per week.

Baking Furnaces Supervisor - He directs and supervises the facilities and employees of the anode baking furnaces according to the general directives of the Carbon Plant Superintendent. Also, since the baking furnaces operate continuously while green anodes and rodding operate only five days a week, the Carbon Plant Shift Supervisors report to him and he is also responsible for the movement of anodes (green to storage, baked to storage, storage to baking furnaces, storage to rodding, rodded to storage, storage to potrooms). He supervises the baking cycle of the anodes, including positioning and packing of the anodes into the pits, advance of the flame, removal and inspection. He supervises a work force of about 68 persons.

Rodding Supervisor - He directs and supervises the facilities and employees of the Rodding Section, according to the directives of the Carbon Plant Superintendent. These facilities include the removal of bath and carbon from spent anodes returning from the potrooms, removal of the cast iron joint, cleaning and repairing the stubs and rods, preparing the cast iron in the induction furnace, joining a new anode to the rod, and covering the new anode with a layer of aluminium. He directs a work force of about 55 persons.

Cast House Planning Supervisor - He directs and supervises the employees of the Planning Section of the Cast House, according to the directives of the Cast House Superintendent. He has to satisfy the requirements of the Sales Division within the constraints of the quality and quantity of metal that is received from the potrooms. He assigns the metal from different pots to the different holding furnaces and plans what alloys have to be prepared and cast. Since he is not directly responsible for the operation of any physical facilities, his staff consists of the cast house four shift supervisors, two assistants and two clerks.

Furnace and Casting Supervisor - He directs and supervises the facilities and employees of the Furnace and Casting Section, according to the directives of the Cast House Superintendent. The physical facilities under his responsibility include the holding furnaces that receive the metal coming from the potrooms, the casting furnaces, where alloy mixtures are prepared, and the various casters. (DC pits, 20 kg-ingot, continuous caster for rod, or for flat products). He directs a work force close to 100 persons, which include foremen, hourly workers and clerks.

Finishing and Shipping Supervisor - He directs and supervises the employees and facilities of the Finishing and Shipping Section according to the directives of the Cast House Superintendent. He is responsible for the heat treatment of extrusion billet and for sawing both billet and rolling ingot to desired size. He is also responsible for the storage of the finished product, its preparation for shipping, and its loading onto trailers and trucks. To accomplish these tasks he leads a work force of about 65 persons.

Potlining Supervisor - He directs and supervises the facilities and employees of the Potlining Section according to the directives of the Production Services

Superintendent. Facilities directly under his responsibility include equipment for potlining and equipment used for mix preparation (although some is shared with the green carbon plant). He ensures that potlining design and installation procedures are adhered to, and that materials used meet required standards (the latter with assistance of the Technical Division). His work force will depend on the relining rate which means, ultimately, on the potlining life. We can expect, however, that it will not be under 50 persons.

Ladle Maintenance Supervisor - He directs and supervises the facilities and employees responsible for the maintenance of the equipment used for tapping metal from the pots and for transferring the liquid metal to the holding furnaces. (If the plant sells liquid metal to outsiders, he would also be in charge of maintaining the vessels used to make the deliveries, if such vessels belong to the smelter.) He works according to the directives of the Production Services Superintendent. He leads a work force of about 20 people.

Fume Exhaust Supervisor - He directs and supervises the facilities and employees of the Fume Exhaust Section according to the directives of the Production Services Superintendent. He is responsible for the operation of the system that removes the fumes generated at the pots from the potrooms, including maintenance of the pot hoods, piping, exhaust fans, mechanical collector of particulates (if it exists), etc. We can consider two alternatives: 1) that the fumes, after removal of some of the particulate matter, are dispersed into the atmosphere from tall stacks (120 to 150 meters), perhaps one per potline; 2) that the fumes go through a dry scrubbing system where most of the fluorine is captured by the alumina to be used in the pots, and then the clean fumes are dispersed into the atmosphere from shorter (60 meter) stacks. In the second alternative the Fume Exhaust Supervisor is also responsible for the operation of the dry scrubbing system. In this case he will lead a work force of about 30 persons.

Production Shift Supervisor (16) - There are four shift supervisors in each potline, reporting to their respective line supervisors, four in the Carbon Plant, reporting to the baking furnaces supervisor, and four in the Cast House, reporting to the Planning Supervisor. They direct and supervise the foremen in their respective production units. They fulfill both operational and administrative functions and must be able to make operational decisions under emergency situations where no person of higher authority is present at the plant.

Production Foremen (89) - There are sixteen foremen in the potroom, 36 in the carbon plant, 22 in the cast house and 15 in production services; in all cases they report to their immediate supervisors, under whom they fulfill operational functions. They have direct responsibility over crews of hourly workers performing specific tasks and must ensure that such tasks are performed safely and efficiently.

Maintenance Supervisors and Foremen - The three maintenance departments-- mechanical, electrical and civil-- have Section and Shift supervisors, as well as foremen. Their numbers appear in the chart of Section 2.2. Jobs descriptions for them are not really necessary in this Report since the functions they have to perform are those of their trades, and only influenced in a minor way by the fact that they are performed in an aluminium plant. For example, the foreman of the air compressors shop is responsible for the maintenance of the air compressors, and such maintenance is almost entirely independent on whether the compressors are installed in a mine or in an aluminium smelter. Therefore, such job descriptions are omitted here, although they would certainly have to be included in a real plant.

Chemical Laboratory Supervisor - He directs and controls the work and facilities of the laboratory of chemical analysis, according to the directives of the Laboratory Superintendent. His tools are those of analytical chemistry and in some cases, particularly in the measurement of fluorine levels in air and plants outside the smelter, very refined techniques are required. His work force numbers 12 people.

Spectrographic Laboratory Supervisor - He directs and controls the work and facilities of the spectrographic laboratory, according to the directives of the Laboratory Superintendent and in close coordination with the Cast House Superintendent and the Sales Division. He supervises the preparation of the samples and is responsible for the proper operation of a very sophisticated spectrograph and on-line computer. He leads a work force of 8 people.

Sampling Supervisor (2) - He directs and controls the obtention of samples of air, water, plants and animals according to the directives of the Environmental Control Superintendent (one supervisor works inside the smelter complex, the other outside). He supervises the operation of the sampling equipment, labels the samples and delivers them to the laboratory, receives the laboratory reports and participates in their analysis.

Traffic, Industrial Relations and Administrative Division Supervisors - Job descriptions are not given for the same reasons invoked in the case of Maintenance. The Traffic Division also has foremen in all three of

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Traffic, Industrial Relations and Administrative Division Supervisors - Job descriptions are not given for the same reasons invoked in the case of Maintenance. The Traffic Division also has foremen in all three of its departments to direct various forms of materials handling activities.

II - Hourly Workers - Production

IIa - Potrooms

Potroom Crane Operator (32) - He operates the overhead cranes in the potroom. These cranes are used routinely for two activities: anode changing and metal tapping. Both operations are simple but require care in their performance since considerable danger to fellow workers and damage to equipment will ensue from negligent operation.

Tapping Crew Leader (8) - He is responsible for the operation of removing the liquid metal from the pots by means of a vacuum system. He checks out the equipment before the operation, and supervises and participates in the tapping. He directs the work of three men: the crane operator, a tapping helper and a metal carrier. He has to fill in forms recording the weight of metal tapped from each pot.

Tapping Crew Helper (16) - He helps in the tapping operation. Connects the vacuum system, places and removes the pipe that is inserted into the pot, helps place the crucible on the trailer.

Hot Metal Carrier (8) - He drives the tractor that pulls the metal containers from the potrooms to the cast house. Removes the dross from containers.

Pours metal into holding furnaces. Drives liquid metal containers to and from containers repair shop.

Mobile Equipment Operator (48) - He drives either a crust breaker, an alumina feeder, a fluorides feeder or a floor sweeper.

Anode Changing Crew Leader (8) - Changes the anodes according to a schedule prepared by the line supervisor. During the operation he supervises the cranemen and has two helpers.

Anode Changing Helper (16) - He assists in the anode changing operation, breaks the crust around anodes to be removed with a portable breaker, removes excess of bath, cleans up floor next to the pot, helps placing spent anode on trailer and in picking up a new one.

Senior Pot Attendant (32) - He performs the operations necessary for the smooth functioning of the pot, such as: introduction of a wooden pole in case of anode effect, raising the anode beam, taking samples for the laboratory, correcting the proportion of aluminium fluoride, removing pieces of broken anodes, repositioning of anodes that slip down, cleaning coal dust from the bottoms, etc. He supervises a helper.

Assistant Pot Attendant (32) - He helps the senior attendant in the performance of all his functions, and substitutes for him in case of his absence.

Senior Controlman (16) - He makes measurements, including preparation of measuring equipment, of all the pot parameters required by the supervision, for example, total voltage drop, temperature of the bath, current distribution among the anodes, voltage drop at the cathode, etc. He supervises a helper.

Assistant Controlman (16) - He helps the senior Controlman in the performance of his functions, and substitutes for him in case of his absence.

IIb - Carbon Plant

Paste Production-Grinder Operator (6) - He is responsible for the grinding of the petroleum coke, and the classification of the grains by size.

Paste Production-Mixer Operator (6) - He supervises the dosification of the ingredients that go into the mixers, including preheating operations, and also supervises the mixing and the unloading of the mix.

Vibrator Operator (12) - He is responsible for the operation of the vibrating machine that forms the green anodes and for the discharge of the anodes into the cooling facilities.

Anode Carrier (16) - He drives the trailers that carry green, baked and spent anodes in and out of their place of production and storage.

Senior Baking Furnace Attendant (4) - He organizes and supervises the work of his crew of furnace attendants.

He inspects the pits both empty and when loaded. He controls the overall operation of the furnace, fills in the forms regarding production, operating parameters, etc.

Furnace Attendant (12) - He performs routine control of the installations; he regulates fires and gas pressures; moves the fire from pit to pit; checks the fume exhaust systems; cleans the pits. He supervises a helper.

Craneman (8) - He operates the overhead crane in the baking furnace facility. From the crane he loads and unloads the pits, helps in moving the fire, helps in the repair of the pits.

Assistant Furnace Attendant (16) - He helps the furnace attendant in moving the fire; takes samples for the laboratory; removes defective anodes; helps in cleaning the pits.

Spent Anodes Cleaner (6) - He removes the bath from the spent anodes by means of a pneumatic hammer and hand tools.

Rod Repairman (6) - He inspects the rods after carbon and cast iron have been removed. He cuts the tips that cannot be reused and welds new ones. He straightens bent rods.

Induction Furnace Attendant (3) - He prepares the raw materials to be loaded in the induction furnace; loads the furnace and controls its operation; pours out the metal; cleans the furnace; operates the facility for reutilization of scrap.

Cast Iron Pouring (3) - He pours the cast iron to weld the rod to the anode. Removes the dross from the caster and keeps it clean. Maintains the temperature of the cast iron in the caster. Supervises the flow of rodded anodes to the aluminizing station.

Aluminizing Crewleader (3) - He secures the aluminium to feed the furnace. Supervises the operation of the furnace. Inspects the incoming and outgoing anodes. Supervises two helpers.

Aluminizing Assistant (6) - He picks up a rodded anode from the conveyor, places it in proper position and sprays the molten aluminium. Takes the finished anode to the loading station and places it on a trailer.

IIc - Cast House

Senior Furnace Operator (4) - He controls the arrival of metal to the holding furnaces; controls the operating parameters of these furnaces; determines when the metal has to be transferred to the casting furnaces and supervises the transfer; supervises the treatment of the metal in the casting furnaces (e.g., fluxing, additioning of alloying materials); takes samples for the laboratory; controls the temperature and is responsible for having the metal ready for casting. Supervises a crew of three helpers.

Assistant Furnace Operator (12) - He performs all the functions connected with the operation of the holding and casting furnaces according to the directives of the senior operator.

Ingot Casting Crew Leader (4) - Prepares the equipment to direct liquid metal towards the ingot caster. Controls the flow of metal into the molds and controls the operation of the caster. Supervises two helpers.

Ingot Casting Assistant (8) - Assists the crew leader in the preparation of the equipment. Removes the ingots from the molds, stacks them on a pallet, straps the stacks and carries them to the loading station or storage area.

D-C Casting Crew Leader (4) - He supervises the set up of all the equipment involved in D-C casting (channels, filters, molds, water sprayers, etc.). Checks that the metal in the casting furnace is ready for casting; supervises the preheating of the channels; takes samples of metal for the laboratory; supervises the casting and controls the appropriate parameters (e.g., speed, temperature); supervises the removal of the cast products; records what products have been cast and supervises their markings. He leads a group of four helpers.

D-C Caster Operator (16) - Executes all the operations involved in D-C casting according to the directives of the crew leader. Maintains the equipment clean and properly stored. Delivers the products cast to the intermediate storage area for further processing.

Continuous Caster Crew Leader (4) - Supervises the preparation of the equipment; checks that the metal in the casting furnace is ready for casting; takes samples for the laboratory; sets the operating parameters of the caster; makes record of quantity and quality of product. Supervises a crew of three helpers.

Continuous Caster Operator (12) - Executes all the operations involved in continuous casting according to the directives of the crew leaders. Keeps the equipment clean and looks after the storage of interchangeable parts. Delivers the products to the storage or loading areas.

Senior Saw Operator (8) - Operates the controls of the saw, chooses the proper accessories for the product to be cut; verifies that adequate supply of products is available to carry out his assigned program, prepares the appropriate lubricants for the job to be performed; carries out the sawing operation. Supervises two helpers.

Assistant Saw Operator (16) - Brings to the saw and feeds the material to be cut. Gathers, weighs, labels and straps the cut product. Gathers, weighs, labels and carries to the proper storage areas the cut ends and defective pieces. Helps the senior operator at his request.

Chips Press Operator (4) - Feeds the chips into the press. Straps, weighs and labels the bales of compressed chips. Supervises one helper.

Chips Assistant (4) - Gathers the chips from the saws and brings them to the press. Carries the bales to the appropriate storage area.

Homogenizing Crew Leader (4) - Supervises the loading of the extrusion ingots onto the appropriate trays. Sets the controls of the homogenizing furnace. Supervises the homogenizing cycle. Supervises two helpers.

Homogenizing Assistant (8) - Prepares the products and loads them on the tray. Labels the finished products and delivers them to the storage or loading areas.

Shipping Crew Leader (3) - Verifies that the products that are scheduled to be loaded are available in storage. Verifies the weight of all bundles, etc. to be loaded. Checks the loading record against that of the truck driver. Supervises three helpers.

Shipper Assistant (9) - Drives the lift trucks or mans the loading crane used to place the aluminium products on the trucks, trailers or railroad cars used for delivery to buyers.

Dross Operator (4) - Gathers the dross from the cast house furnace. Operates the mill used for grinding it. Packages the ground dross for delivery to the buyer.

IId - Production Services

Potrelining Crew Leader (2) - Supervises the execution of the relining operations; in particular, he checks the temperature of the incoming mix and that of the finished layers; verifies that the crew members are using the proper tools and that the tools are in good repair; supervises and ascertains that the construction of the layers of brick is done according to the blueprints; supervises the installation and final positioning of the cathode blocks and bars. He leads a crew of six workers.

Potreliner (12) - Executes all the operations involved in relining: lays and rams the mix, lays the bricks, places the cathode blocks, positions the insulating material, positions the cathode bars for welding. Brings the raw materials to the working area. Cleans the working area and tools.

Potlining Mix Operator (4) - Operates the equipment to prepare the mix used for relining.

Driver, Potlining Mix Truck (1) - Delivers the potlining mix prepared at the green carbon plant to the relining crews.

Old Lining Removal Crew Leader (2) - Decides when a pot that has been disconnected from the series is ready to initiate the operations of removal of the old lining. Programs the work. Is responsible for adopting measures that will maximize the safety of his own crew and minimize the disturbance to the rest of the potroom. Supervises the execution of the work. Heads a crew of six workers.

Old Lining Remover (12) - Breaks up the old lining with drill hammers and other power and hand tools. Loads broken linings for removal from the potrooms. Cleans the pot shell and leaves it ready for relining.

Driver, Old Linings Truck (1) - Takes the fragments of old linings out of the potrooms and dumps them in the proper disposal area.

Cathode Assembly, Crew Leader (2) - Supervises and participates in the execution of the assembly. In particular, he is responsible for the alignment of the bar and for pouring the cast iron that welds the bar to the carbon block. Guides the work of two assistants.

Cathode Assembler (4) - Helps the crew leader in positioning the bars; brings the cast iron to be poured; helps in the pouring; removes the assembled block and takes it to storage; brings new blocks and bars to be assembled.

Pot Rebuild Welder (3) - Cuts the welds between the busbars and the cathode bars in pots to be relined. Welds the new cathode bars to the busbars after the pot is relined. Supervises two assistants.

Pot Rebuild Assistant Welder (6) - Cuts the welds between the busbars and the cathod bars in pots to be relined without need of supervision. Helps to weld, or welds under supervision, the new cathode bars. Secures the supply of inert gas, welding rods, tools, and accessories reouired. Cleans the work area.

Pot Exhaust Maintenance Crew Leader (2) - Makes routine inspection of pot hoods and exhaust pipes from the pots to either the stacks or the dry scrubbers. Reports to the foreman and assists in programming maintenance activities. Decides what parts must be scrapped or sent to the main shop for repair. Supervises the work done by a crew of six.

Pot Exhaust Maintenance Crew Member (12) - Makes in situ repairs of hoods and exhaust pipes. Removes for transfer to the shop those parts that cannot be repaired in situ. Installs new or repaired parts.

Scrubber Operation Crew Leader (6) - Measures and records all the operating parameters; supervises the running of the installation. Programs and supervises the servicing of the scrubbers. Has three assistants.

Scrubber Operator (18) - Inspects the filtering elements; replaces filters as necessary; cleans the filters; cleans the working area; records all filter changes.

Ladle Cleaner (2) - Inspects the ladles; supervises the cleaning, removal of old refractory lining; installation of new lining. Makes final assembly of relined ladle and checks for air and metal tightness. Supervises four assistants.

Ladle Cleaner Assistant (8) - Breaks old lining; installs and dries new lining. Cleans tapping pipe and other accessories.

III - Hourly Workers - Non Production

IIIa - Maintenance

For the same reasons invoked in the case of Middle and Lower Level Supervisors, no individual description will be given for the jobs of maintenance hourly workers. For the sake of completeness we list below the designations of maintenance workers according to a Labour Agreement signed in 1977 between a local of the United Steelworkers of America and one U.S. aluminum producer (the list goes from the least skilled to the most skilled job. In some cases the same job description appears in more than one job classification, since there may be several skill levels within the same designation.)

Job Classification	Job Designation
4	Sweeper
7	Trucker
8	Tool crib attendant

Job Classification	Job Description
9	Painter
10	Oiler
11	Carpenter-Helper Serviceman-Painter
12	Yard equipment operator
13	Carpenter-Painter
14	Refractoryman
15	Carpenter
16	Automotive mechanic-Electrician-Fabricator High voltage AC repairman-Machinist-Maintenance Mechanic-Maintenance Welder-Refractoryman-Substation Electrician
18	The same as 16
20	The same as 16 and 18 plus: Instrumentation Technician-Substation operator
22	Instrumentation technician

In a Canadian labour contract of about the same date, in addition to the above the following job designations are found:

Blacksmith
Brickmason
Pipefitter
Groundskeeper
Concrete repair (journeyman and helper)
Air conditioning mechanic
Tool reconditioner

IIIb - Traffic Division

Again it is sufficient to give just job designations:

Conveyorman
Trucker
Lift truck driver

Front loader driver

Materials handler

Warehouseman

Truck and railroad car loader

Several positions are specific to the wharf operation:

Crane operator
Winch driver
Hatch signalman
Hold man
Lead hand
Sling man

IIIc - Others

The Industrial Relations, Administrative, and Development and Engineering Divisions do not have hourly workers.

The Technical Division has a few hourly workers who are responsible for bringing to the laboratory the samples to be analyzed. They can be classified as drivers since they pick up the samples in some kind of motorized vehicle (small car or three-wheeled motor scooter).

Section 2.4 Initial and Final Skills of the Personnel

The preceding Section gives Job Descriptions for 94 different positions in the smelter, mentions explicitly 52 other positions for which no descriptions are given but only designations, and lumps into very broad categories (such as "maintenance supervisors and foremen") some 25 to 30 other distinct positions. This brings the total number of different jobs in a smelter to about 175.

From the point of view of the initial and final skills required of the people that will fill these jobs, the procedure followed in this Report has been to group most of the 175 positions into skill categories, and only a few of the more critical jobs have been treated individually. This is sufficient for the purposes of evaluating the possibilities of the local labour market in a feasibility study, but would require considerably more elaboration when an actual project is launched.

The material is presented in tabular form, with different Tables for different skill categories.

Table 6

MANAGERIAL LEVEL

Job Description	Education	Experience at Hiring	Additional Requirements
General Plant Manager	University Graduate	Fifteen to twenty years in industrial activities, the last five to ten as manager of a plant or a major division of a heavy industry-type operation. Experience in directing staff and in industrial relations.	Visits to operating smelters to see different technologies. In depth visit (few weeks) to a smelter of similar technology. Acquire general picture of the aluminium industry.
Works Manager	University degree in science or engineering	Ten to fifteen years experience in industrial activities, last five as production or maintenance manager of a large metallurgical operation. Experience in directing staff is most important.	Will visit a similar smelter during the early stages of the project. Returns to site in time to participate during construction and erection. Must acquire in-depth knowledge of smelting technology.

Job Description	Education	Experience at Hiring	Additional Requirements
Production Manager	University degree in science or engineering	Ten to fifteen years in industrial or commercial activities, three as a manager of a section involved in an industrial process-type operation. Experience in directing staff and foremen, and in labour relations, is most important.	In-depth knowledge of the functions of the Production Division to be acquired at a similar smelter. Returns to the site when lining of pots and/or anode production begins.
Maintenance Manager	University degree in engineering	Ten to fifteen years in industrial process industries, five as a maintenance manager in a heavy industrial process-type operation. Experience in directing staff and foremen, and in labor relations, is most important.	Should be at the site since the beginning of construction, since he needs to acquire thorough familiarity with all the equipment at the smelter.
Technical Manager	University degree in engineering or chemistry	Ten to fifteen years industrial experience, four as a manager of a department where technical control is required for successful operation of an industrial process. Experience in directing graduate engineering staff and understanding of technical control procedures very important.	Has to become familiar with all chemical analysis required in the smelter and with its potential environmental problems. He will be at the site when first raw materials begin to arrive.
Development and Engineering Manager	University degree in science or engineering	Fifteen years experience in applied science, industrial R & D, or design engineering in the areas of materials science, metallurgy or metallurgical plants.	Visits to smelters at the very onset of the project. Involvement in the engineering of the project.

The Traffic, Industrial Relations and Administrative Managers must meet the same requirements as men in similar positions in industries of similar size.

Table 7

SENIOR SUPERVISORY LEVEL

Job Description	Education	Experience at Hiring	Final Skills
Reduction, Carbon, and Casting Super intendents	University degree in engineering	Ten years process industry experience, four in direct charge of an operating section. Experience in directing staff, foremen and large work force very important.	Detailed and thorough knowledge of the operation to be supervised in their respective departments.
Production Services Superintendent	University degree in engineering	Ten years industry experience, four in direct charge of a maintenance section or technical section with emphasis on quality & operation control.	Must become intimately familiar with potrelining operations, and with scrubbing systems if the smelter has them.
Mechanical and Electrical Maintenance Superintendent	University degree in engineering	Ten years industry experience, four in direct charge of a maintenance section in a heavy industry operation.	Familiarity with the equipment in the smelter.
Buildings & Grounds Maintenance Superintendent	University degree in civil engineering	Ten years experience in construction, four in industrial structures.	Familiarity with the civil works of the smelter.
Laboratory Superintendent	University degree in chemistry	Ten years in analytical laboratories, three as manager of a laboratory or a large section of a laboratory.	Thorough familiarity with the analytical chemistry of fluorine, aluminium raw materials and aluminium and its alloys.

Job Description	Education	Experience at Hiring	Final Skills
Environmental Control Superintendent	University degree	Ten years experience in industry, either in production, maintenance, laboratory or industrial health. Some public relations experience is useful	Thorough familiarity with smelter effluents, health hazards, abatement techniques, related pollution standards & legislation
Chief Metallurgist	University degree in science or metallurgy	Ten years experience in metallurgical industry, four in aluminum fabrication or secondary smelters. Experience in quality control	Knowledge of aluminium alloys and their uses
Development Superintendent	University degree in science or engineering	Ten years experience in his profession, four in industrial research	In depth knowledge of the technologies involved in the aluminum and related industries
Engineering Superintendent	University degree in engineering	Ten years experience in industry, four with engineering firm managing a section in charge of design of some aspect of industrial installations	Familiarity with the equipment at the smelter and with the equipment of other smelters

Superintendents in the Traffic, Industrial Relations and Administrative Divisions must meet the same requirements as men in similar positions in industries of similar size.

Table 8

SUPERVISORS

Job Description	Education	Experience at Hiring	Final Skills
Potline Green Anodes Baking Furnace Rodding Cast House Planning Furnace and Casting Finishing & Shipping	Minimum of two years of technical schooling beyond high school. Preferably university degree in engineering	Five to ten years experience in heavy industry, three as general foreman in production sections. Capacity to administrate and organize work crews most important	In depth knowledge of the operations to be performed in their respective Sections
Potlining Ladles Fume Exhaust Mechanical Maintenance Electrical Maintenance	Two years of technical schooling beyond high school	Five to ten years experience in heavy industry, three as general foreman of maintenance section. Capacity to lead foremen most important	Familiarity with the equipment in the smelter, in particular that of their direct responsibility
Chemical Laboratory Spectographic Laboratory Sampling	Technical school degree in chemistry or laboratory technician	Five to ten years experience in university or industrial chemical laboratory, three with responsibility over other personnel	Familiarity with the specific equipment and functions of their Sections
Shift	Two years of technical schooling beyond high school	Five to eight years experience in heavy industry, three as foreman	Familiarity with the specific equipment and functions of their Section

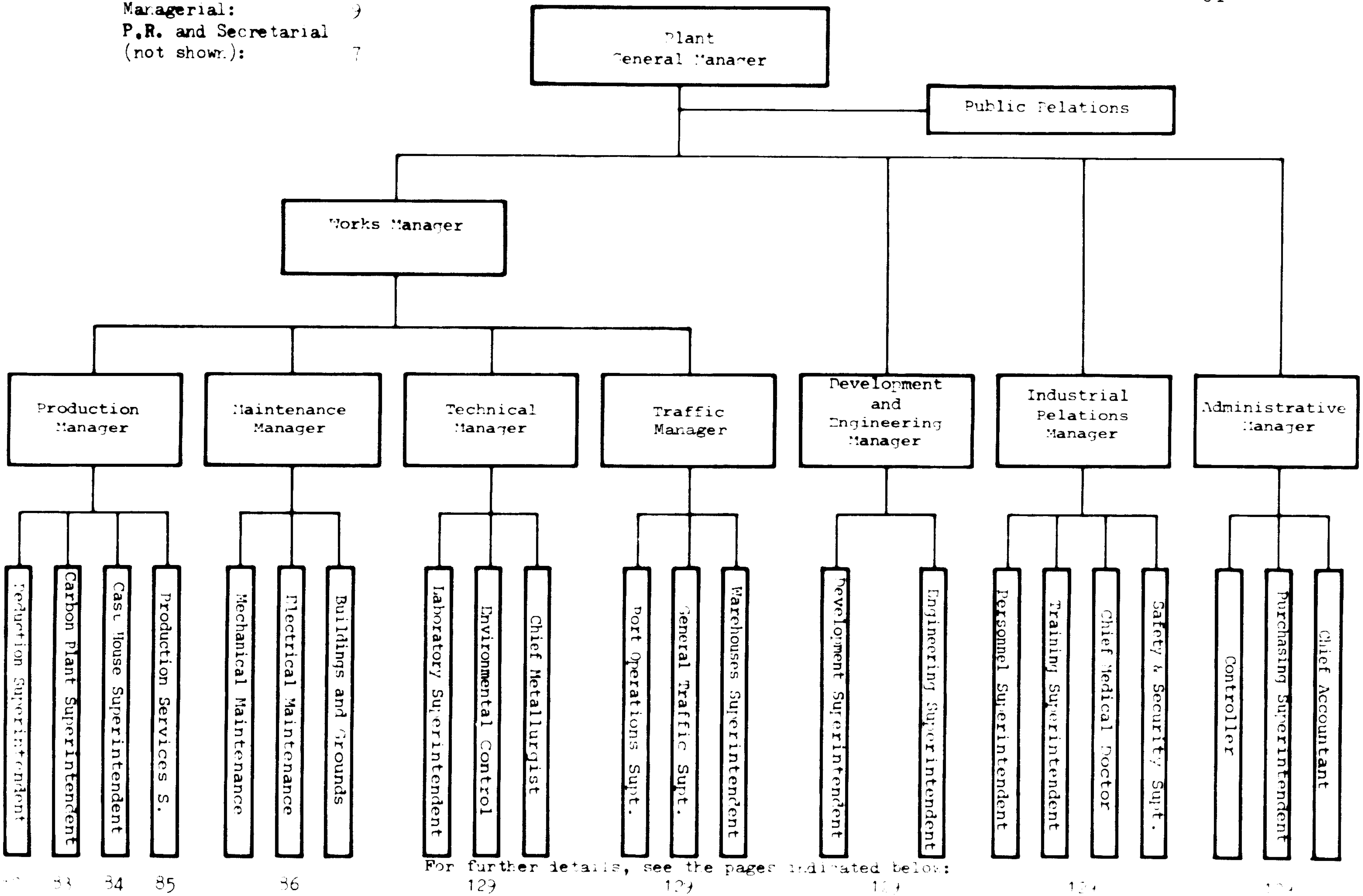
Table 9

FOREMEN AND HOURLY WORKERS

Job Description	Education	Experience at Hiring	Final Skills
Foreman	Two years of technical schooling beyond high school	Five years experience in heavy industry, two as foreman or crew leader. Proven leadership ability	Detailed knowledge of the functions to be performed by all men under his supervision
Skilled Workers	Diploma from a trade school or equivalent training	Five years experience in his specific trade	Familiarity with the smelter
Semi-skilled workers	Elementary school, complete (7 or 8 years of schooling	Some previous industrial experience, preferably in shift work	Familiarity with the equipment and functions of his Section
Unskilled Workers	Four years of elementary schooling	Some previous industrial experience, preferably in shift work	Familiarity with the function to be performed

It should be emphaisized that the above educational and previous experience requirements correspond to what is defined as "basic scenario" in Chapter 4, but would be too ambitious for the case of a less developed country. On the other hand, the final skills requirements cannot be relaxed, which means that if the initial skills described above cannot be met, longer training and expatriates become necessary. These problems will be discussed in detail in Chapter 4.

Managerial: 9
P.R. and Secretarial
(not shown): 7



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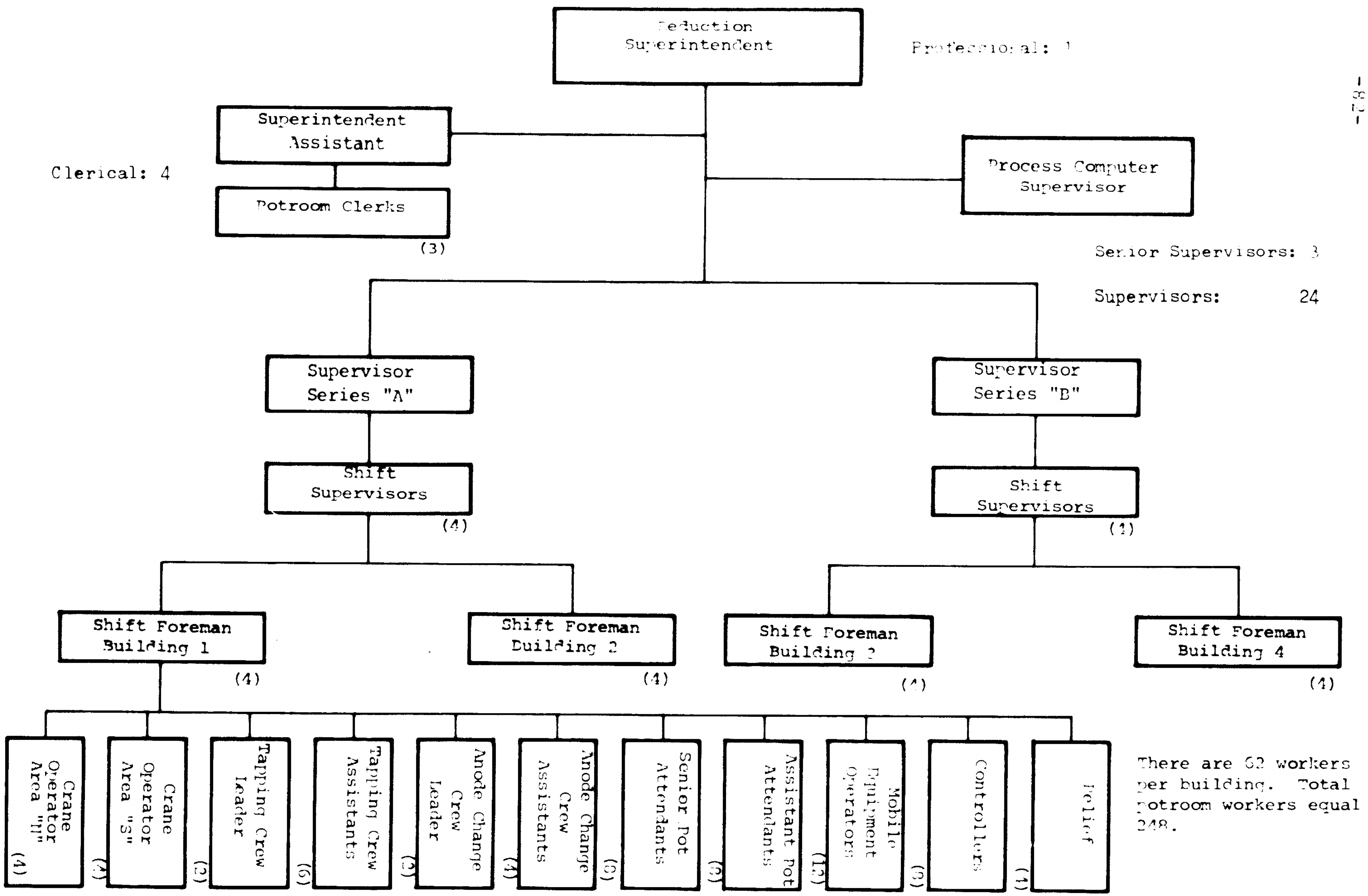
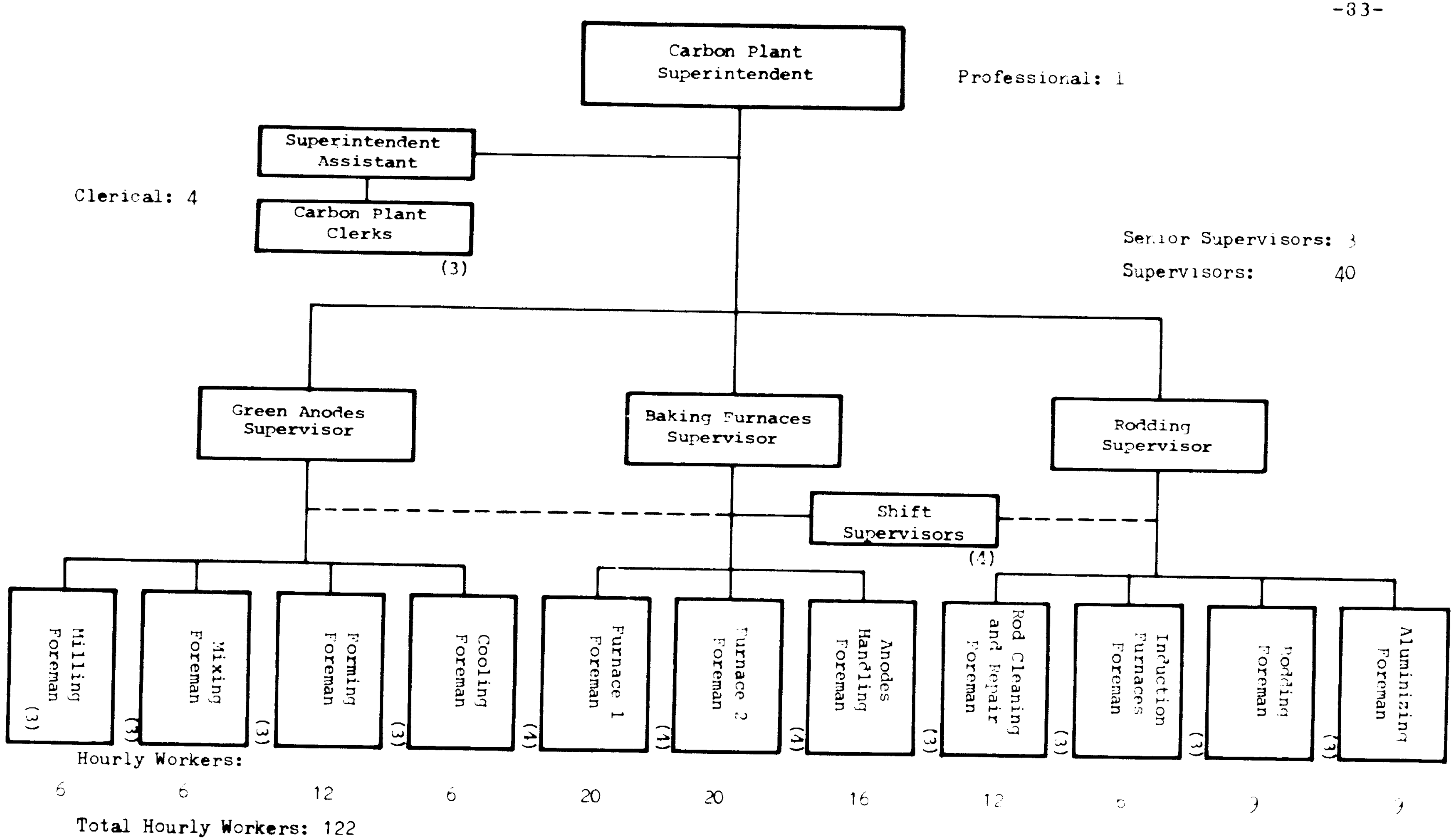
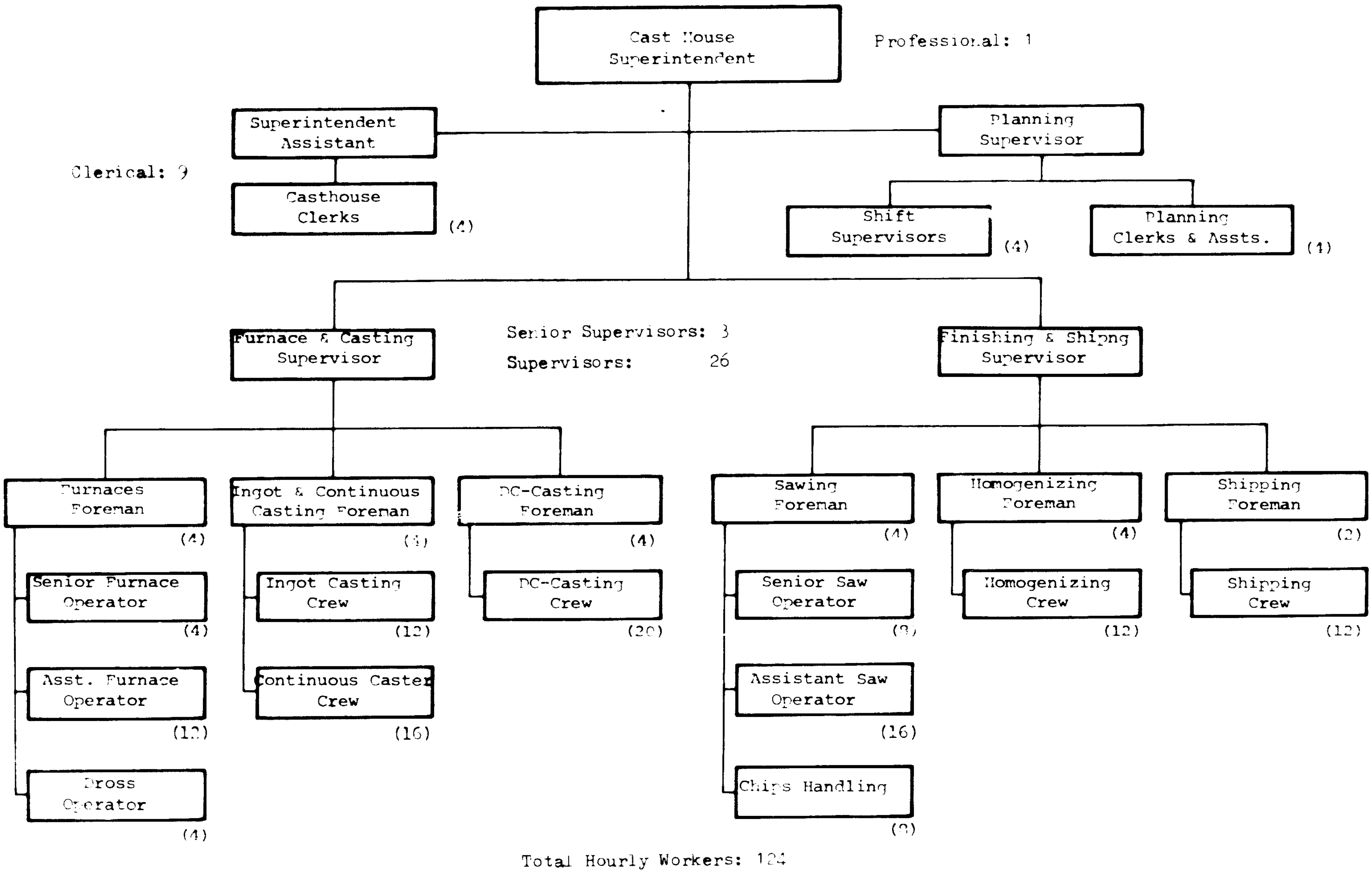

Reduction Superintendent
Professional: 1
Superintendent Assistant
Clerical: 4
Potroom Clerks (3)
Process Computer Supervisor
Senior Supervisors: 3
Supervisors: 24
Supervisor Series "A"
Shift Supervisors (4)
Supervisor Series "B"
Shift Supervisors (4)
Shift Foreman Building 1 (4)
Shift Foreman Building 2 (4)
Shift Foreman Building 3 (4)
Shift Foreman Building 4 (4)
Crane Operator Area "N" (4)
Crane Operator Area "S" (4)
Tapping Crew Leader (2)
Tapping Crew Assistants (6)
Anode Change Crew Leader (2)
Anode Change Crew Assistants (4)
Senior Pot Attendants (8)
Assistant Pot Attendants (8)
Mobile Equipment Operators (12)
Controllers (8)
Relief (1)
There are 62 workers per building. Total potroom workers equal 248.


Carbon Plant Superintendent
Professional: 1
Superintendent Assistant
Clerical: 4
Carbon Plant Clerks
(3)
Senior Supervisors: 3
Supervisors: 40
Green Anodes Supervisor
Baking Furnaces Supervisor
Rodding Supervisor
Shift Supervisors
(4)
Milling Foreman
(3)
Mixing Foreman
(3)
Forming Foreman
(3)
Cooling Foreman
(3)
Furnace 1 Foreman
(4)
Furnace 2 Foreman
(4)
Anodes Handling Foreman
(4)
Rod Cleaning and Repair Foreman
(3)
Induction Furnaces Foreman
(3)
Rodding Foreman
(3)
Aluminizing Foreman
(3)
Hourly Workers:
6
6
12
6
20
20
16
12
9
9
Total Hourly Workers: 122



Cast House Superintendent
Professional: 1
Superintendent Assistant
Clerical: 9
Casthouse Clerks
(4)
Planning Supervisor
Shift Supervisors
(4)
Planning Clerks & Assts.
(4)
Furnace & Casting Supervisor
Senior Supervisors: 3
Supervisors: 26
Finishing & Shipng Supervisor
Furnaces Foreman
(4)
Senior Furnace Operator
(4)
Asst. Furnace Operator
(12)
Dross Operator
(4)
Ingot & Continuous Casting Foreman
(4)
Ingot Casting Crew
(12)
Continuous Caster Crew
(16)
DC-Casting Foreman
(4)
DC-Casting Crew
(20)
Sawing Foreman
(4)
Senior Saw Operator
(8)
Assistant Saw Operator
(16)
Chips Handling
(8)
Homogenizing Foreman
(4)
Homogenizing Crew
(12)
Shipping Foreman
(2)
Shipping Crew
(12)
Total Hourly Workers: 124

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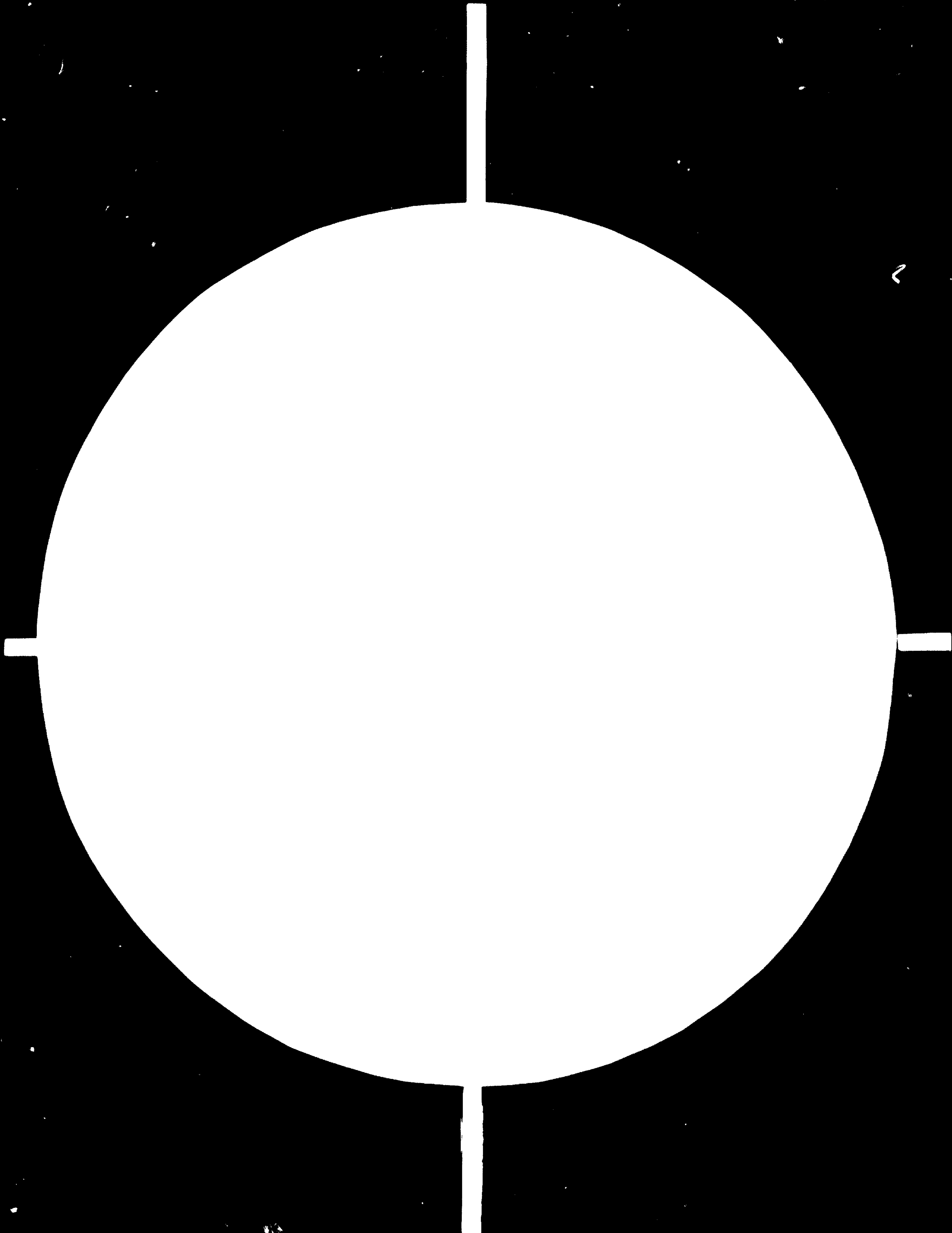

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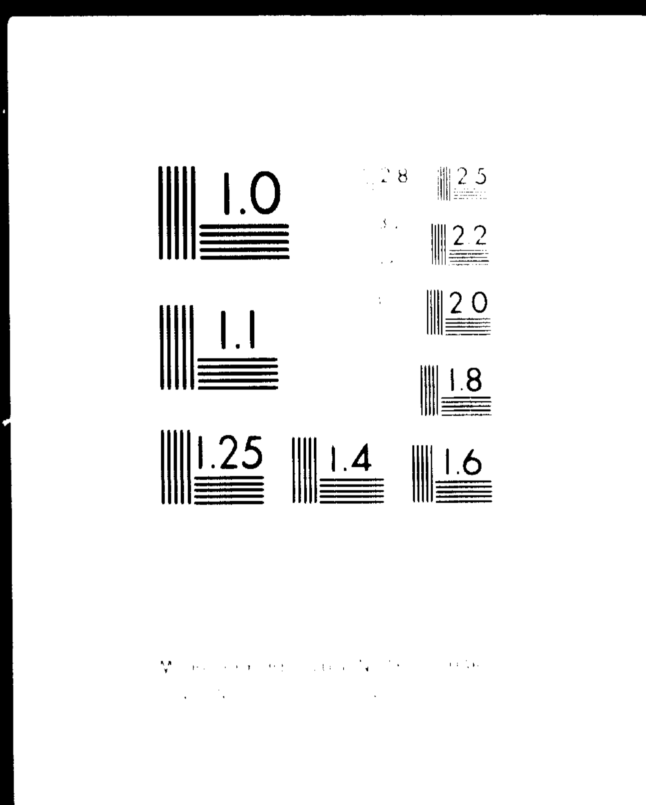

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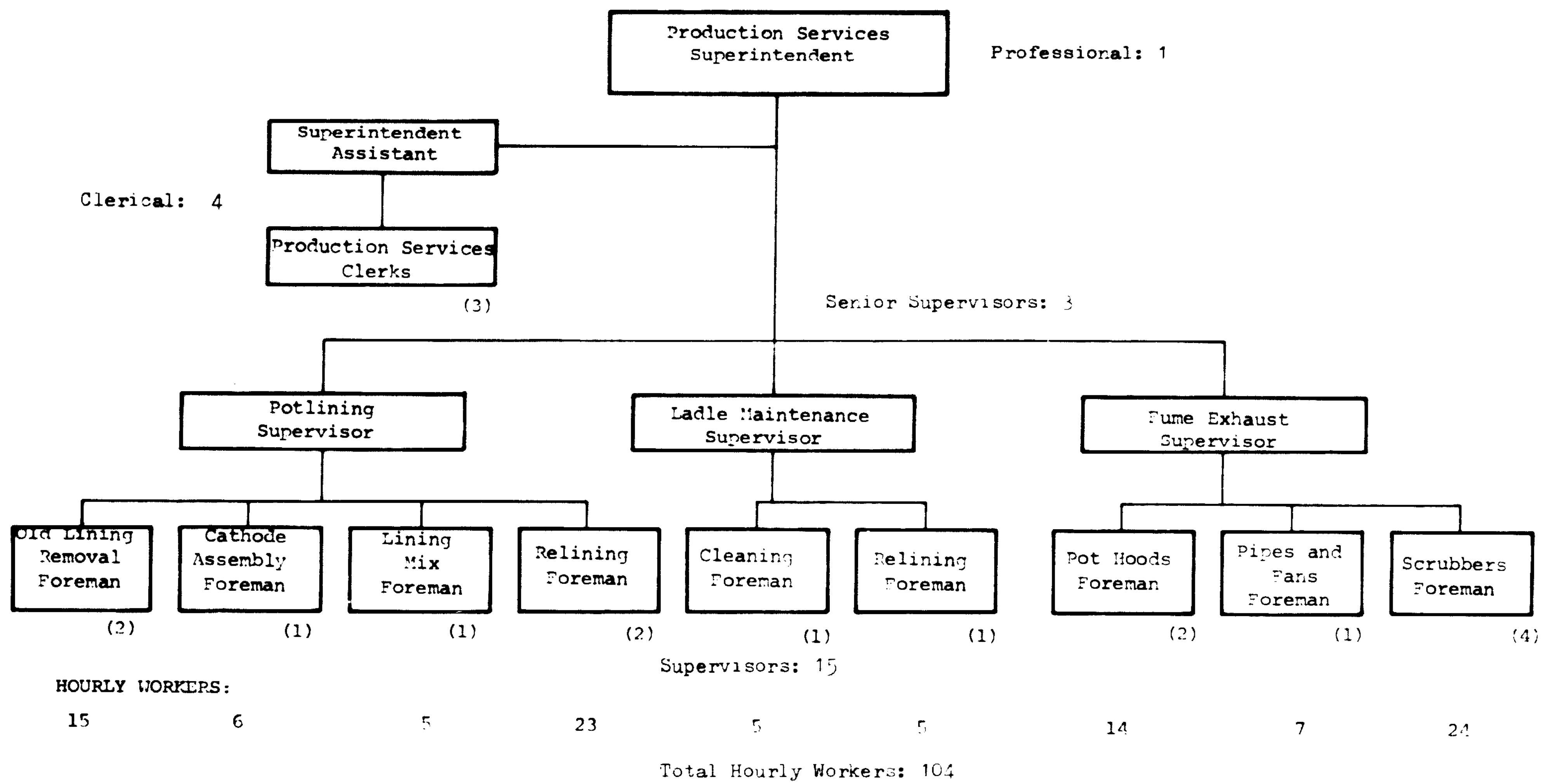
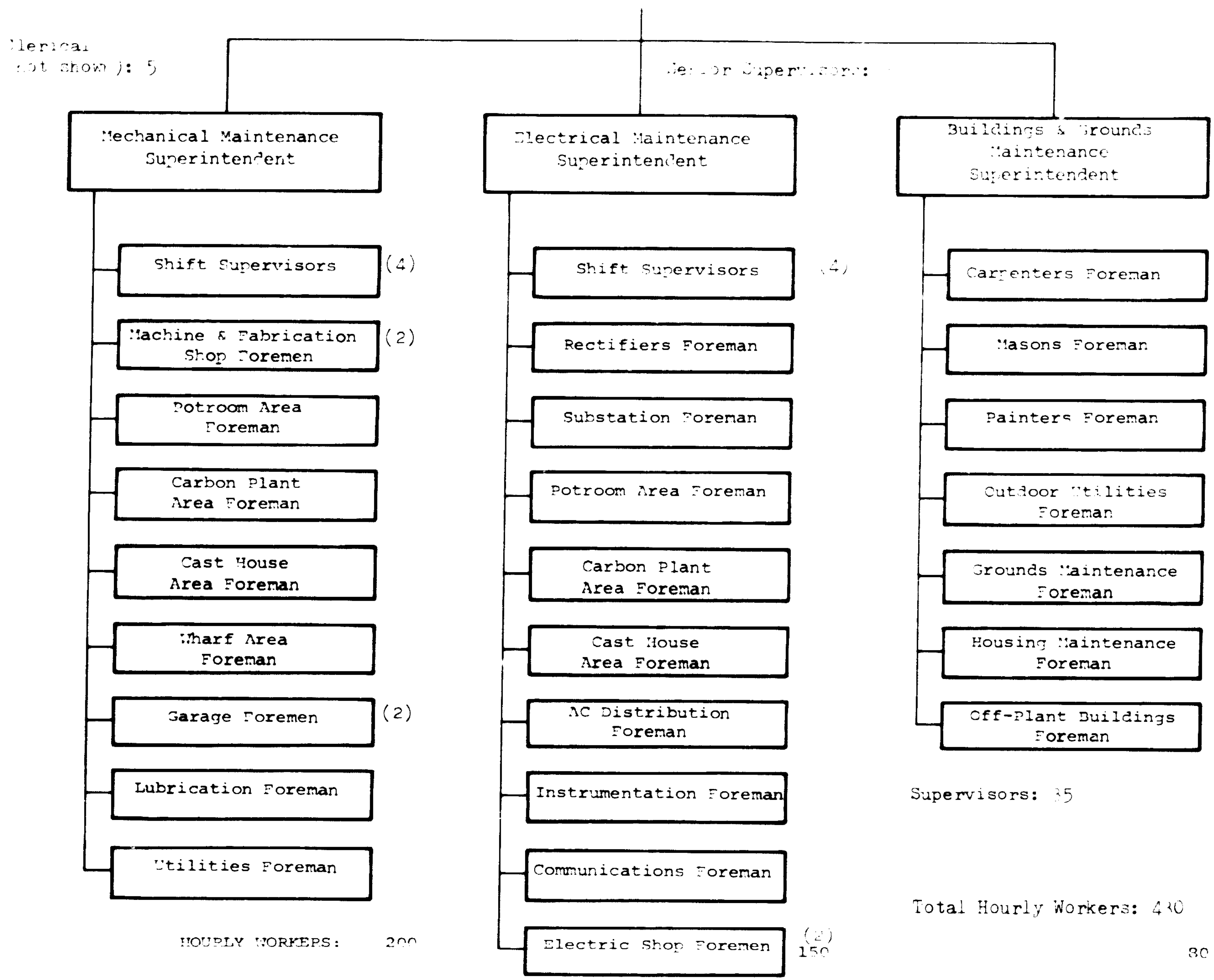

Production Services Superintendent
Professional: 1
Superintendent Assistant
Clerical: 4
Production Services Clerks
(3)
Senior Supervisors: 3
Potlining Supervisor
Ladle Maintenance Supervisor
Fume Exhaust Supervisor
Old Lining Removal Foreman
(2)
Cathode Assembly Foreman
(1)
Lining Mix Foreman
(1)
Relining Foreman
(2)
Cleaning Foreman
(1)
Relining Foreman
(1)
Pot Hoods Foreman
(2)
Pipes and Fans Foreman
(1)
Scrubbers Foreman
(4)
Supervisors: 15
HOURLY WORKERS:
15
6
5
23
5
5
14
7
24
Total Hourly Workers: 104


Clerical (not shown): 5
Senior Supervisors:
Mechanical Maintenance Superintendent
Shift Supervisors (4)
Machine & Fabrication Shop Foremen (2)
Potroom Area Foreman
Carbon Plant Area Foreman
Cast House Area Foreman
Wharf Area Foreman
Garage Foremen (2)
Lubrication Foreman
Utilities Foreman
HOURLY WORKERS: 200
Electrical Maintenance Superintendent
Shift Supervisors (4)
Rectifiers Foreman
Substation Foreman
Potroom Area Foreman
Carbon Plant Area Foreman
Cast House Area Foreman
AC Distribution Foreman
Instrumentation Foreman
Communications Foreman
Electric Shop Foremen (2)
150
Buildings & Grounds Maintenance Superintendent
Carpenters Foreman
Masons Foreman
Painters Foreman
Outdoor Utilities Foreman
Grounds Maintenance Foreman
Housing Maintenance Foreman
Off-Plant Buildings Foreman
Supervisors: 35
Total Hourly Workers: 430
80

Chapter 3 TRAINING OF STAFF FOR ALUMINIUM SMELTERS. ACTUAL EXPERIENCE OF DEVELOPING COUNTRIES

Section 3.1 General Description of Smelters Visited

The program called for visits to six smelters, two in Latin America, one in a relatively less developed country of Europe, one in Africa and two in Asia. The smelters were chosen so as to give as wide a spectrum of technologies as possible, considering the smallness of the sample. Some basic information on the six smelters is given in Table 10.

As can be appreciated from the Table, all smelter sizes are > 70,000 TPY. The technologies are from both East and West and the sample includes both Soderberg (Vertical Studs) and prebaked (both side break and center break) cells.

The smelters are very different from each other in ways that influence the subject of this report. Fundamentally, these differences have to do with the local labour markets.

The two Venezuelan plants are located in an area of low population density where an extraordinary industrial and building construction boom is taking place. Everything is in short supply in the area, from housing to berth space for the freighters that line up along the Orinoco River unable to unload. And one of the items in shortest supply is labour, at any level of skill. Since skilled labour scarcity is a general situation in Venezuela, recourse is made to imports of labour from abroad. Such high excess of demand leads to high wages, large turnover and an attitude of fire-me-if-you-dare from

Table 10

Description of the Smelters Visited

Name of Company	Location	Capacity	Type of Cell	Supplier of Technology
ALCASA	Puerto Ordaz Venezuela	120,000[1]	Prebake, 40% side break, 70 kA, 60% center break 150 kA	Reynolds
VENALUM	Puerto Ordaz Venezuela	280,000[2]	Prebake, center break, 150 kA	Reynolds
Aluminium de Grece	Distomon Greece	145,000	Prebake, side break, 67% 65 kA, 33% 85 kA	Pechiney
Egyptalum	Nag Hammadi Egypt	100,000[3]	Soderberg V-S 150 kA	Soviet Union
Aluminium of Bahrain	Bahrain	120,000	Prebake, side break, 100 kA	Alumetal/ Kaiser
Bharat Alu-inium, Co.	Korba, M.P. India	100,000[4]	Soderberg V-S 100 kA	Soviet Union

[1] 50,000 TPY capacity reached in 1973, 70,000 TPY expansion built in '77, not fully operational at time of visit (July '78).

[2] First cells energized 2nd quarter '78. Full capacity may be reached in '80.

[3] An expansion of 66,000 TPY is under construction using same technology.

[4] Only 50,000 TPY were operational at time of visit (September '78) because of power shortage.

many workers. Under such circumstances the smelters are driven towards trying to achieve a production of metal per employee as high as possible, by increasing the capital expenditure in automation and labour saving devices. Also, they are forced to hire many non-local Venezuelans and foreigners, a large fraction of whom are not seriously considering settling in the area but are only attracted there by the possibility of making some quick money and then returning home. These smelters will move in the direction of capital intensiveness.

At the other extreme of the spectrum are the smelters in Egypt and India, built in areas not of boom but rather of poverty and economic stagnation, in countries short of capital and with abundant supply of labour. The smelter in Egypt probably has the lowest output of metal per worker in the world and, in spite of that, the incidence of labour in the cost of production is also one of the lowest in the world. But nothing could be more foolish for Egypt than to spend scarce foreign currency reserves in imported equipment to drive workers out of the smelter. From the point of view of the aluminium company itself it would make no sense because labour costs are already so low, that further savings in labour--even if half or two-thirds of the work force were dismissed--would not compensate the service of the debt incurred in buying labour saving equipment. And from the point of view of the country, it is obvious that in Egypt all investment should be made with a view towards job creation, not job elimination. In India both metal output per worker and wages are higher than in Egypt, so that labour costs per tonne of metal are comparable. It is again true in India that job creation is of higher priority than a reduction in labour costs. Because of the local labour market conditions both smelters enjoy low turnovers and draw most of their workers from the local population.

The smelter in Bahrain presents a peculiar situation. It was intended to be a labour intensive plant mainly because in the late sixties it was feared that a situation of large unemployment was looming over the island. After start-up the labour force swelled indeed to rather large numbers compared to most other smelters in the world, and it is still quite large today. However, the expected unemployment situation in Bahrain failed to materialize and today the smelter is, on the one hand, reducing its labour force, and on the other, bringing labour from abroad (Pakistan, India, Philippines) because not enough Bahrainis are found to fill all the posts. Wages and turnover have both risen and special fringe benefits, in particular, access to housing, will be provided by the company to improve the stability of the labour force. In addition to workers from the East, the Bahrain smelter has, since its construction days, kept a fairly large fraction of Western expatriates (currently around 5%), higher than in Venezuela (practically no expatriates are kept by either the Egyptian or the Indian smelters).

The smelter in Greece is the only one visited where ownership is 100% foreign (Alcasa is 50% foreign, Bahrain and Venalum about 20% and Egypt and India are fully local). It was constructed at a site that was convenient from the point of view of the location of the sources of bauxite (the industrial complex includes an alumina plant both for the needs of the smelter and for export), had a very good natural harbour, and had the approval of the Greek government. On the other hand, only a small fishing village was in the immediate neighborhood of the plant. Hence, a company town had to be built, and most labour had to be brought from other villages, or even from other parts of Greece. These conditions have resulted in large personnel turnover.

How personnel is trained in these six smelters will be discussed in the Section that follows. Other questions related to personnel, such as housing, medical care, safety, and so forth, will be discussed in Section 3.3.

Section 3.2 Highlights of Training Practice in the Visited Smelters. Methods and Resources. Remarks of Comparative Character

ALCASA and VENALUM. These two smelters can be considered together since, first, they are in close physical proximity, second, one party--an agency of the Venezuelan government--owns 50% of one company and 80% of the other, and third, both smelters have received the technology and have management contracts with the same group, namely, Reynolds International, Inc. Alcasa was built about ten years before Venalum which means that the second smelter can take advantage of the training facilities developed for the first.

To a large extent, training is done through a specially created company, AVADAL (Venezuelan Association for Training and Developing in Aluminum) whose facilities are located just outside Alcasa's fence. AVADAL relies strongly on audio-visual aids, one of which describes the activities of AVADAL itself. Quoting from its text, "Our training covers mainly the specific operational aspects of aluminum production, beginning with the carbon anode, stressing the electrolytic reduction process in the potrooms, to produce liquid aluminum metal that will be later transformed into different products in the casthouse. At AVADAL we have prepared specialized courses that include technical aspects of the following kind: Preparation of the cathode blocks for assembly in the pot, including operations such as fitting the different components in the pot shell and the ramming of the blocks and walls; Production of carbon anodes, including the baking furnaces in the Carbon Plant; Preparation of the rod and welding it to the carbon anode; Placing anodes in the pots; Operations necessary prior to energizing a series, and for the start up of the pots; Operational aspects such as the replacement of spent anodes, measurement of the levels of metal and bath, raising the anode beam, tapping of metal from the pot and transportation of the liquid metal to the cast house, cast house operations.... Similarly, at AVADAL we train personnel in other areas such as: the operation of fork lifts; the operation of special equipment such as the anode changing machine; courses in American English.... Our training utilizes modern audiovisual equipment that include T.V. cameras, video tape recorders, equipment synchronizing images and sound, and slide projectors for individual or group training." At AVADAL they designed a training technique that was very successful. Again I quote from written information provided by them:

"We formed work groups, each composed of:

- A veteran expatriate production supervisor, recognized by the parent company as an expert in his area.
- A local bilingual typist.
- A local bilingual engineer or technician with supervisory experience in industry
- 2 to 4 local people with supervisory skills or at least supervisory potential.

AVADAL had up to three such groups working at one time under the supervision and guidance of a qualified training specialist with long experience in the industrial and educational fields. The work groups were expected to achieve the following objectives:

1. Capture, in writing, all the useful "know-how" relative to his specialty that the veteran foreman, or "subject matter expert" (SME) brought with him, whether in notes, files, manuals, or in his head.
2. Edit and organize in a logical sequence, with the help of the training specialist, all the useful

material generated by the SME, including that developed in the inter-action with the other group members.

3. Under the guidance of the training specialist, prepare in teachable form in both languages, according to the desired format, the abovementioned material, written objectives, tests and answers, including audio-visual aids.

   NOTE: translation into the local language will begin as early as step 1.

4. Impart the developed material to the remainder of the new work force as required by start-up schedules. Depending on particular departmental requirements on-the-job training may be integrated with classroom training as part of the curriculum.

Note that a key aspect of this system is that effective training begins as soon as the group is assembled. Ideally the SME should be the supervisor (or advisor) during start-up and shake-down periods. The local people assigned to his group should be the cadre he keeps with him during those phases of the operation. By assembling the group early, those involved will go into the critical start-up period as part of a seasoned team and the situation will be much better than trying to assemble a group of strangers to work together shortly before start-up. Another favorable aspect is that by having his group generate, prepare and teach their own training material a genuine commitment to the training program is achieved.

The old SME is an indispensable part of the group. He must like and enjoy working with the local people. Don't fret about his not knowing their language; there's not enough time to do anything about it anyway.

By working closely with his group he will find out a lot about how to handle a crew of local production workers after start-up. Learning can be a two-way street.

When the SME has unburdened himself of every bit of useful knowledge about the process, it has all been translated into the local dialect and put into the correct format, including audio-visual materials, the bilingual typist can be assigned to her new office in the plant. Then the most apt supervisor should be enrolled in a brief course on how to handle himself as an instructor and the new trainees, including hourly rol', can be hired and started on the training program under his care. The SME will take the rest of the group out to the plant, now nearing completion, and make preparations for start-up. Another option at this time would be for the SME to take the supervisory group to an operating plant elsewhere, where they can experience the actual situation they will find later on at home. If conditions are such that they can actually get involved and obtain "hands-on" experience it can be very beneficial.

AVADAL is pleased with the positive results obtained from this technique, which we must admit was not planned. It was more the fortunate fall-out from accepting the challenge of trying to do in two years what conventional wisdom held should take three and a half to four years to accomplish."

Finally, we should note that Alcasa has also been involved in active training of personnel outside Venezuela. Well in excess of 100 nationals have been trained in other plants for periods averaging about six weeks, for positions up to superintendent level. It is expected that a large fraction of the approximately 50 expatriates now at Alcasa (up from about 10 a few years ago because of the recent expansion that more than doubled capacity) will be replaced with local personnel within two years and that within five years there should be very few, if any, expatriates.

Aluminium de Grèce. This smelter belongs to a wholly owned subsidiary of Aluminium Pechiney of France and, therefore, the manning and training problems are tied to the general corporate plans and structure. In Greece, Pechiney keeps a group of expatriates with previous experience in the aluminium industry in several key positions, and this situation is likely to continue into the future without much change. These expatriates assist in the training of the personnel, most of which is made on the jobsite, starting during erection and start-up of the plant, and still continuing. Pechiney also organizes special courses in France for foremen from their subsidiaries, similar to the courses given to French foremen.

In general, the turnover of hourly workers is large (about one third of all workers hired leave within one year) and it is especially serious in the potrooms. A new potroom attendant is typically trained on the job for two months before he is actually put to work by himself, and he is expected to be fully competent in six months. The training of maintenance workers presents a much greater problem particularly since there are no technical schools in the area and no cooperative program has yet been developed between the company and the government for the establishment of facilities for vocational training in the trades. Practically all the training is done on the job and workers can progress from helpers to tradesmen as they gain experience and skill.

Aluminium of Bahrain (Alba). Alba has a Training Department whose Superintendent reports to the Personnel Manager. Training activities are given great importance and at present are being carried out on the basis of plans elaborated with the participation of all the plant departments. Their fundamental premise is that the departments must assume responsibility for developing their own personnel in conjunction with the training department. This includes nomination by the departments of the employees from their own work forces who will receive training abroad.

The activities of the Training Department include the following:

a) Programs for the assessment and reassessment of personnel; these include English, mathematics and aptitude tests aimed at determining the capacity for further training and the developmental potential of the employee. The results also help in deciding the levels of the courses to be offered by the Training Department.

b) Instruction in languages. This includes instruction in English for native employees, and financial support for expatriate supervisory personnel who wish to learn Arabic in existing language schools.

c) Basic education courses, both general and specific. The general courses include English, mathematics and science. Specific courses respond to requests made by the plant departments and are taught according to priorities set by the line departments.

d) Craft training, which takes place at the Alba training center.

e) Development programs for individual employees according to the training plans of the plant departments.

f) Driver training for all vehicles.

g) Foremen training, on the basis of established standards on a plant-wide basis.

h) Supervisory training, which is divided into four groups. One consists of Trainees, or potential foremen, who receive a 15-day, full-time introductory course. Another consists of practicing foremen, who get a 10-day, full-time basic course. A third group is made up of section supervisors and they are given a 10-day, full-time advanced course. The fourth is a mixed group (all of the above plus department heads) and the course covers a more general spectrum of subjects which include Job Evaluation, Interviewing, Communications, etc.

i) Technical courses, that in general form part of the foremen training programs.

At present training activities at Alba are undergoing certain revisions which are the logical consequence of Alba's "maturity." For example, they expect to be able to decrease the number of basic education courses, to give greater emphasis to craft training on-th-job, and to put a good deal of effort into the training of local foremen and supervisors in order to achieve a greater "Bahrainization" of the staff.

Bharat Aluminium Company (BALCO). Balco is a government owned enterprise and runs an integrated aluminium complex--mining of bauxite, production of alumina, production of metal--that was built at a relatively recent date (the first production of metal occurred in May, 1975), when India already had considerable experience in aluminium in plants with Canadian, U.S.A. and Italian technologies.

This latter fact made it possible for Balco to fill two of its top management positions with senior people with respectively 8 and 12 years experience in private smelters, and five middle management positions with more junior people also with previous experience in the aluminium industry. For seven other management positions trainees were hired without previous exposure to aluminium, and a special training program was prepared for them. BALCO has no intention, however, of hiring any more executives from outside the firm, so that the training of management personnel will be no longer necessary.

A similar situation to the one just described occurred with the initial cadre of supervisory personnel. That is, for start-up, Balco sought to hire persons with previous experience in the aluminium industry. As soon as possible, however, BALCO started to train its own supervisors and this training program, of course, continues.

For supervisory positions Balco recruits graduates in engineering or science (three years of education beyond their high school diploma) who then receive training by the firm. In the order of 25 to 30 people were sent for training to the Soviet Union, to work in a smelter of similar technology, for periods ranging between four and nine months. In India they are subject to training programs on the job and also to so-called developmental training, which involves attendance at special practical courses, and to technical institutes that have management programs in the technical, production, personnel, and general management fields.

For operators, tradesmen and assistant foremen, Balco recruits trainees between the ages of 20 and 25, with an intermediate science or trade certificate, which then follows a two-year training program. The first six to twelve months are spent in a training institute run by BALCO; then they are [illegible] to t[illegible] [illegible] they [illegible] eventually occupy, until the [illegible] sufficiently skilled. The great majority of Balco's skilled workers actually started as trainees.

Semi-skilled workers are required to have elementary schooling (through eighth grade) and are mostly trained on the job. The unskilled workers, manual labourers, receive practically no training, and although Balco prefers to hire personnel who can read and write, such ability is not a requisite for hiring.

Aluminium Company of Egypt. No written information on their training programs was provided by Egyptalum. What could be gathered during the visit to the smelter is that a sizable number of Egyptian nationals at the managerial, supervisory and foreman levels spent periods of six to twelve months at the Bratsk smelter in the Soviet Union. During start-up Soviet personnel were in Nag Hammadi until full capacity was attained. At present practically no Soviet experts are involved in the operation of the smelter; those at Hag Hammadi are involved in the construction of the Soderberg paste plant (which was almost completely installed at the time of the visit) and in the construction of the 66000 tonne per year expansion.

Apparently personnel for the plant are trained on the job. There is very little turnover which facilitates the training. The number of workers is very high and management is not concerned with attaining high productivity.

Comparative remarks. From the smelters visited one general impression that emerges is that not much attention was paid to the labour requirements of the smelter when the site was chosen. In other words, both physical and political factors played their role in site selection, but the long range effects of the composition of the local labour market were hardly taken into account. Perhaps the circumstances forced the planners to give low priority to labour availability in the feasibility study, maybe it was just assumed that once a source of employment was created, workers would naturally flock towards it. This is a dangerous assumption, though, and future planners would be well advised to pay greater attention to the labour problem in the early stages of the project.

The need for training was, of course, better perceived everywhere and all smelters have made, and continue to make, important efforts in this field. Rather than compare at this point the observations gathered in this group of six smelters, they are incorporated in Chapter 4, dealing mainly with training programs, and Chapter 5, dealing mainly with suggestions, together with the experiences of other smelters in developing countries, either visited by the author at other times, or described to the author either verbally or in writing during the research that led to the present report.

One last remark before closing this Section. If a smelter has a large turnover, it is essentially training people for the benefit of other employers. Therefore, training efforts must be combined with incentives to keep the workers within the firm. Because of man's natural desire for improvement, training should not stop when a man is capable of filling a slot in the organizational chart, that is, training should not be restricted to newly hired workers. Adherence to this policy was not observed in all of the smelters visited.

Section 3.3 Some General Recommendations and Conclusions That Can be Derived from the Experience of the Smelters Visited

Chapter 5 of the present Report contains sections dealing explicitly with recommendations and conclusions that can be derived from the study undertaken, related to the specific questions of manning and training schedules in smelters. In the present Section reference will be made to other aspects of the general subject of personnel, not directly related to their quantity, quality or training but more to their working conditions, what one may call the "quality of life" of smelter personnel.

The subject is perhaps of not very great importance in the highly industrialized countries. In those, the smelters are responsible for providing a healthy and safe atmosphere in the working areas, and adequate facilities where the workers can eat, receive first aid, wash and change clothes, and park the cars they drive to work. The main social responsibility of the smelter is to avoid pollution of the environment, but there is very limited participation of the smelter in the private lives of its workers beyond battery limits.

The situation can be, and normally is, radically different in the developing countries, and at least four areas can be given as examples: housing, medical attention, entertainment, and education. Other areas, such as meals, transportation, and clothing are also of great importance in smelters--or any other major industrial projects--in many developing countries. Therefore, although these problems are only tangential to the central subject of this Report, they deserve some remarks.

In the six smelters visited, housing was a problem that management could not ignore. As mentioned in Section 1.4, the same is true of most other smelters in developing countries from which data are available.

Running a housing program is probably much more difficult than running a smelter, and plant general managers do not necessarily qualify as charismatic community leaders. Therefore, if housing is a problem and the smelter has to do something about it, the best solution, conditions permitting, is to give the employee a housing allowance to either rent, buy or build his living quarters, rather than build a company town. Chances are that whatever efforts are made, the company will get more criticism than praise for what it builds and how it runs it.

Exactly the opposite is true of medical services. People everywhere and of all levels have great respect for the medical profession and can develop a great sense of gratitude if they feel their health is well taken care of. The company should build and run first class medical facilities for its workers and their families if no such facilities exist in the immediate neighbourhood of the smelter. Such philosophy is probably wiser than contributing funds for third party run hospitals or clinics.

Another area in which the smelter should take the initiative is that of entertainment, particularly if it is built in a remote area and workers have to be brought in from other parts of the country. Sport activities, cinema and other recreational programs have to be provided or subsidized by the company.

If the construction of the smelter causes a significant increase in the local population, it is very likely that the smelter will have to build, and if necessary also run, a school to provide at least elementary education, and establish a fund to help deserving students to continue their education elsewhere in the country.

Finally, it was verified in all the smelters visited that the workers have to be provided with: free or very cheap transportation between the smelter and their homes; one meal at a price at or below cost to the company(in one case it was gratis); work clothes, including safety boots, hard hats, goggles and other safety equipment as required. At one smelter visited such articles (except goggles) were not provided; it gave a very poor impression to see workers dressed in any way they could. It probably contributes to a poor safety record and low morale.

Chapter 4 TRAINING PROGRAMS AND SCHEDULES FOR ALUMINIUM SMELTER STAFF IN DEVELOPING COUNTRIES

Section 4.1 Description of the Three Scenarios Considered

It was stated in Section 2.1 that there is no such thing as a "typical modern smelter," and that it makes even less sense to attempt to define a "typical" developing country. We have circumvented the problem of the smelter by choosing one of given characteristics and referring manning requirements, job descriptions and personnel skills to that particular choice. When we come to describing training programs, however, it would be too limited a scope to select one country--real or imagined--with a given stage of development and to describe a program appropriate to that country. The differences in degree of industrialization, literacy rates, availability of professionals in engineering and the sciences, availability of managerial skills, infrastructure, and so forth, are so great among the developing countries, that it was considered necessary in the Terms of Reference supplied by UNIDO to state that the Report should: "elaborate typical training programmes for aluminum smelter staff, in several alternatives, as adapted to conditions in developing countries, which are in different stages of development." On the basis of this recommendation three different situations are considered in the remaining Sections of the present chapter: a) a detailed basic scenario which assumes that people with the proper educational requirements but without the necessary final skills as defined in

Section 2.4 are available in the country; b) a "least developed" variation to the basic scenario, in which it is assumed that not all the people with the required education are available; c) a "most developed" variation to the basic scenario, in which it is assumed that some post-training or final skills are already available in the country.

The basic scenario corresponds to a country that is going to build its first smelter, but where the smelter is not the country's first experience in heavy industry. Furthermore, the educational system of the country is well developed, with universities capable of turning out engineers and chemists, with technical schools at a level intermediate between high school and university, that can train tradesmen, laboratory technicians, technical draftsmen, etc. The general literacy level of the country is assumed to be relatively high, so that office clerks, accountants and all levels of management personnel would be available (e.g., Colombia, Philippines).

The least developed case would correspond to a country with very limited human resources and only incipient industrialization. Professionals and tradesmen would be in particularly short supply. Illiterate unskilled workers would have to be hired and part of the labour force imported.

The most developed case is similar to the basic scenario as far as the general level of development of the country and of its educational system are concerned, but additionally the country in question already has at least one operating smelter (e.g., Brazil, India).

Section 4.2 Basic Scenario

The basic assumption in the basic scenario is that enough people can be found in the country with the level of education and experience at hiring stated in the Tables of Section 2.4. The training programs presented here are designed, therefore, to give such people specific training in aluminium smelting but not basic managerial, professional or trades skills. It is further assumed that the smelter will be run by nationals only very shortly after completion of start up. In the next Section we shall consider the case in which one has to build on the basis of a much lower level of local skills, which in turn make it necessary to start the smelter and operate it for several years with a high proportion of expatriates. Training becomes a much slower and longer process and has to go really into basics, such as teaching an illiterate man to read a dial, a farmer to accept shift work, or an elementary school graduate to do practical analytical chemistry.

The training programs described below are to a large extent based on three real cases of independent companies that bought technology from three different major producers. With the advantage of hindsight, I was able to choose what I thought were the best features of the three programs. Combining the programs was not difficult because the three plants are of about the same size and use comparable technologies (prebaked pots of about 1100 kg per day production) and the countries themselves are in similar stages of development.

In the description of the training programs words like "about" or "approximately" in reference to time periods are avoided, mainly not to tire the reader. It should be noted, however, that all such time periods are only indicative, and that any training program accepts a certain degree of flexibility.

I. Managerial Level

General Plant Manager - His managerial ability and experience are more important than his specific knowledge of aluminium smelting. Therefore, his training in aluminium is relatively brief, and it is by no means necessary to hire him at the onset of the project. As a matter of fact, the position could be left vacant during the construction stage since one of the people that have to be hired early may prove capable of filling the job. If this does not happen, he can be hired six months before start up of the first pots, become acquainted with the project, and sent for a period of four weeks to a smelter of similar technology to get a good view of its operations. Before start up he should visit several other smelters to acquaint himself with other technologies. Some readings and quite a few sessions with the senior personnel of the technology supplier at the construction site will round off his education.

Works Manager - When the smelter operations begin (most likely with the production of anodes, although the plant can start with imported anodes), the works manager has to be the highest technical authority among the plant's native personnel. He simply has to know more than the three managers that report to him to command their respect. He has to be hired as soon as the project is launched, and after a briefing of one month at corporate headquarters, he goes for six months to a smelter of similar technology. There he will work with the counterparts of the three managers who will report to him. Then he returns to the site to work very closely with the Project Manager during the early stages of construction, and takes over as Works Manager as soon as production activities begin, assisted by the staff of the technology supplier.

Production Manager - He should be hired fourteen months before the expected start up of the first production activities (to this effect, potlining is considered a production activity). After one month at headquarters and one month at the site, he goes to a smelter of similar technology and works twelve months in its Production Division. His training should be arranged so that he gets to perform all the functions of the superintendents that will later report to him. He returns to the site to fill his job, where at first he is assisted by personnel of the technology supplier.

Maintenance Manager - He should be hired when work at the site has reached the point when the first "above ground" construction begins (i.e., immediately after the first earth moving and foundation work is completed). He has to become familiar with the engineering of the project and participate during the erection of the equipment. During the construction period he will make visits of one week duration to not less than three smelters, and spend one month at a smelter of similar technology. In all these visits he will interact with the respective maintenance managers. He will also make brief visits (two or three days at each place) to the suppliers of major critical equipment, such as the rectifier system, specialized cranes, mobile pot room equipment, anode paste mixers, vibrator, rodding, furnaces and casting equipment.

Technical Manager - He should be hired ten months before the first raw materials are expected to arrive. After one month at the site to become acquainted with the project he will go to the laboratory of a similar smelter where he will become thoroughly familiar with the types of analysis, preparations of samples, and other functions corresponding to his department. Upon return to the site he will have two months to set up his laboratory under the guidance of a member of the staff of the technology supplier. He will also begin to participate immediately in the determination of the background level of pollutants.

Development and Engineering Manager - He should be hired in time to participate in the feasibility study or, at least, in the selection and negotiation of the technology. He should visit not less than six smelters as well as other plants related to smelting such as an alumina plant, a petroleum coke calciner, a fluorides plant and some fabrication facilities. At the site he will act as liaison between the technology supplier and his own corporate headquarters; during construction he will verify that the technical clauses of the technology contract are properly executed, and during the initial stages of operation he will be in charge of the verification of the warranties.

II. Senior Supervisory Level

Reduction Superintendent - He should be hired sixteen months before the expected date for energizing the first pot. After one month at the site to become acquainted with the project he will be sent to a smelter of similar technology to learn all the details of the operation and administration of the potrooms. After one year of training he will return to the site, where he will have three months to organize his initial work force before the first pots go into production, to prepare work norms and safety norms, and to coordinate the training of potroom workers with the Training Superintendent.

Carbon Plant Superintendent - He should be hired fourteen months before the expected date of start up of the carbon facilities. After one month at the site to become acquainted with the project he will be sent to a smelter of similar technology to learn all the details of the operation and administration of the carbon plant. After ten months of training he will return to the site where he will have three months to supervise the last phases of erection of the facilities, to organize his initial work force, to prepare work norms and safety norms, and to coordinate the training of carbon plant workers with the Training Superintendent.

Cast House Superintendent - Exactly the same program as the Carbon Plant Superintendent. He will be hired fourteen months before the scheduled start up of the first pot and his training will follow a similar pattern.

Production Services Superintendent - He will be hired five months before the scheduled start of pot lining operations. After one month at the site to become acquainted with the project and to acquire some descriptive knowledge of his future responsibilities he will travel to a smelter of similar technology, where he will work five weeks in the pot relining shop, one week in ladle maintenance, and two weeks in the scrubbers. He will then return to the site where he will participate in the erection of pot shells and fume exhaust system and in the start up of the equipment for the preparation of the lining mix. The rest of his training will be on the job, working with the contractors in charge of pot lining, busbar and cathode bar welding, erection of the scrubbers, ladle lining, etc.

Mechanical Maintenance Superintendent - He will be hired by the Maintenance Manager within four months of his arrival at the site. His training will be on the job, working with and supervising the contractors responsible for the erection of mechanical equipment and utilities other than electricity. If some equipment is factory tested before shipment, he will represent the owner at the tests. Likewise, he will be responsible for any testing and formal acceptance of delivery of equipment that needs to be done at the site. It would be useful to have him visit briefly one or more smelters before production start up.

Electrical Maintenance Superintendent - He will be hired by the Maintenance Manager within four months of his arrival at the plant. Most of his training will be on the job, working with and supervising the contractors in charge of the erection of the electric equipment. At some point during the construction when no critical equipment is being installed he will spend two months at a smelter with similar transformer-rectifier system and substation, to familiarize himself with their operation and maintenance. It should also be arranged for him to be present during final assembly and testing of the rectifier system at the supplier's shop.

Building and Grounds Maintenance Superintendent - It is highly desirable to hire a man who has acted in a senior supervisory position (or in a junior position but has matured on the job) during the construction of the plant. It may be possible to select a man before construction begins, and arrange with the civil works contractor to employ him (perhaps on a shared-salary basis) until the civil works are finished, at which point he is rehired by the smelter. If no such arrangement can be made, it is sufficient to hire a man with the necessary initial skills six months before metal production begins.

Laboratory Superintendent - He will be hired fifteen months before the scheduled date for first production of metal. He will spend one month at the site becoming familiar with the project. Then he will go for eight months to a smelter of similar technology where he will spend the first two months in the different departments of the Production Division, and the other six in the plant's laboratory, working in its different sections. Upon his return to the site he will join the Technical Manager in supervising the installation of the laboratory, will prepare the work norms and procedures of the analysis to be performed, and will select and collaborate in the training of the personnel.

Environmental Control Superintendent - He should be hired as soon as the site for the smelter is selected and assigned to work with the team responsible for measuring fluorine background (in air, flora and fauna) in and around the smelter site. In the course of this work he will learn all the techniques, and acquire all the theoretical background, required for the fulfillment of his duties at the smelter. He should be allowed and encouraged to attend scientific meetings on the subject of pollution abatement, and environmental and workers protection from pollution.

Chief Metallurgist - He should be hired five months before the scheduled date for the production of first metal. He will spend one month collaborating with the Technical Manager at the site, will spend three months in a smelter of similar production mix, and will return to the smelter one month before metal production begins.

Development and Engineering Superintendents - They should be hired when the project is still in the feasibility study stage. When construction is decided they should become involved with the engineering of the project and the supervision of the erection. During construction they should be given the opportunity to visit other smelters, as well as other plants related to the aluminum industry (Bayer plant, petroleum coke calciner, fabrication facilities, etc.).

III. Supervisors

Potline Supervisors - They will be hired ten months before the start up of the first pot. They will receive a two week introductory course on electrolysis at the site (theoretical, using visual aids), and will then travel to a smelter of similar technology where for another two weeks they will continue to receive theoretical instruction but already in contact with the potrooms. For the next five months they will perform the functions of hourly workers in the potrooms, and then will act as foremen for two months. They will return to the site two months before start up to participate in the last stages of erection and in the hiring and initial training of hourly workers. They will also take a course for supervisors and foremen, and will collaborate in all operations previous to start up.

Carbon Plant Supervisors - They will be hired nine months before the scheduled start up of the carbon plant. They will receive a four week course, partly at the site, partly at a smelter of similar technology, as was described in the case of the potroom supervisors. Then they will spend four months performing the functions of the different hourly workers in their respective sections, and two months acting as foremen. They will return to the site two months before the production of anodes is due to start to participate during the last phases of erection and also in the selection and training of the hourly workers.

Cast House Supervisors - They will be hired nine months before the scheduled day for start up of the first pot. Their training will follow the same pattern as that of the potroom and carbon plant supervisors. When they return to the site, they will participate in the start up of some furnaces and provide the molten metal required for the start up of the pots.

Potrelining Supervisors - They will be hired six months before the scheduled start up of potlining operations. After a two week's course at the site they will go to a smelter of similar technology where they will spend four months executing all operations involved in removing old linings and placing new ones. They will return to the site six weeks before pot lining begins.

Other production Services Supervisors - Their training will follow a pattern similar to that of potrelining supervisors. If the smelter has dry crubbers, the supervisors of this section need to be hired six months before metal production begins. If not, the fume exhaust supervisors can be hired together with the ladle maintenance supervisors, three months before metal production begins, and should have two months of training in a smelter of similar technology.

Mechanical Maintenance and Electrical Maintenance Supervisors - They will be hired beginning immediately after their respective superintendents are established on their jobs. The time of their actual hiring will be determined by the arrival of the equipment for whose maintenance they will be responsible. Their training will be on the job, unless the suppliers of certain major pieces of equipment recommend a maintenance course to be taken at the suppliers' plant.

Laboratory Supervisors - They will be hired immediately after the Laboratory Superintendent returns to the site. Their training will be on the job.

Production Shift Supervisors - There are eight shift supervisors in Reduction (four in each series), four shift supervisors in the carbon plant, and four shift supervisors in the cast house. These men hold crucial jobs since they are the highest authority present at the plant during 75% of the time, and at all times they are the link between higher management and the foremen.

Four of the reduction shift supervisors, and all of the carbon plant and cast house shift supervisors will receive their training in a foreign plant of similar technology. They should be hired together with their respective superintendents and travel about the same time they do to the smelter where they will receive training.

During two thirds of their training period they should perform the various jobs filled by hourly workers in their respective departments, and during the last third they should act as foremen.

They will return to the site one month before the scheduled start up of production of the facilities to which they are assigned. During this month they will become acquainted with the local work and safety norms and with the personnel of their departments.

IV. Foremen and Hourly Workers

All foremen and hourly workers will be trained at the site, and mostly on the job.

Foremen will be hired three months before they are supposed to take on their jobs. During these months they will participate in the final phases of construction of their respective sections, and they will receive training by means of lectures and visual aids on the specific jobs they are supposed to perform.

Skilled workers are involved mostly in maintenance activities. In such cases they are hired as needed and put immediately on their jobs, after only a brief (one week) introduction to the smelter and aluminium technology done through lectures and visual aids. If the job to which a worker is assigned is specific to the aluminium industry and, therefore, new to him, he will be hired two to four months before he is to be assigned to the job (depending on the job's complexity) and will be trained by working next to an expatriate performing the same functions.

Semi-skilled workers fill a large fraction of the production functions. They are hired one to three months before production is expected to start in the section in question. The date of hiring will depend not only on the complexity of the job but also on the availability of equipment to train them. For example, a crane operator in the baking furnace has to be trained by actually operating the crane before any anodes go into the furnace, but this means that at least one crane has to be ready for training about two months before the furnace is started. In addition to training obtained through "mock" operations, training will also continue by having local workers mix with the crews brought by the supplier of technology for start up.

Unskilled workers will be hired as needed and trained on the job.

Section 4.3 The Case of a Less Developed Country (LDC)

A number of countries which could profitably build a smelter because they are well endowed with either bauxite or hydroelectric potential, or both, face a situation of very limited human resources. The difficiencies in initial skills can be very substantial if compared to the Tables of Section 2.4. In such cases the training program outlined in the previous section is inapplicable: The smelter will have to accept the presence of a fairly large number of expatriates for relatively long periods of time, and will have to decide on what basic philosophy to adopt with regard to training.

Indeed, the training program outlined in the previous section responds to a very clear philosophy: the smelter has to train the personnel that it requires for its own needs, taking the best it can get from the local labour force. But in the case of an LDC the possibility of being able to adopt such a philosophy is far from obvious.

In one of the smelters visited the question of the philosophy of training came up in a conversation with the Training Superintendent. As he put it, when the training department defines training, it takes it to mean the actions necessary to insure that adequate manpower is available to get the job done. Top resident management will put more emphasis on the company's image and will be more aware of political necessities. The Board of Directors of the company will be concerned with the social responsibility involved in the training process. Finally, from the point of view of the government of the host country, training should include the establishment of schools and other facilities that will increase the total skilled manpower of the country and will avoid pirating of personnel from one company to another, and also help in substituting expatriate staff by local skills.

In the LDC case the training program is likely to be guided, in the long run, by the philosophy of the host country government, and the smelter will have to be subsidized, directly or indirectly, for the additional cost of the program. The program will have to include training for as many levels as possible simultaneously, but could hardly expect to achieve independence from expatriates in less than ten years.

We shall describe the program beginning from below. It is likely that some training will be required even for unskilled workers, particularly if it becomes necessary to hire illiterates. In such cases it would be advisable to have the workers attend a program equivalent to three years of elementary schooling, in addition to special classes where they will be taught to read dials, digital displays of numbers and capital letters, and to operate simple instruments.

The elementary schooling program would be mandatory for any unskilled illiterate worker who aspires to be promoted to the category of semi-skilled worker, since it will be expected that semi-skilled workers should be able to write very simple reports and understand written norms or instructions. Most of the training of semi-skilled workers will be on the job, although before they are attached as trainees to a working crew, they should have classroom exposure to what they are going to do, both through lectures and visual aids, and through mock operations in the training shop. In addition, the smelter needs to maintain a driving school since over 200 people capable of driving a large variety of vehicles are employed in the plant, and one of the spare cranes in the potrooms can be set aside to be used by cranemen trainees.

By far the most difficult levels to fill in a LDC are those of skilled workers and lower supervision. Because of the social structure of many developing countries, the supply of engineers to the labour market may be relatively larger than the supply of skilled workers. On the other hand, the skilled workers are the group in greatest demand as soon as a construction boom or industrialization project gets underway.

If the host country does not have the necessary facilities, the smelter will have to establish a technical school, which will probably have to fill the dual role of providing secondary education and, at the same time, produce both tradesmen and technicians. People admitted into the school should have previously completed the equivalent of an elementary education, and their ages could be anywhere between 15 and 25 years. In very rough terms, the school could be considered to be a basic two-year program concentrating on mathematics, physics and chemistry, after which the student could have a choice of taking another two year course in a trade (carpenter, electrician, welder, machine tool operator, pipe fitter, etc.) or a four year course leading to a technical diploma in mechanics, electricity, electronics, chemistry or civil construction. Arrangements should be made for a person with a trade certificate to be able to go for a technical diploma without need of going through the entire four year course. Also the technical diploma should give some advanced standing towards an engineering degree at the university.

If the school is run by the smelter, the students should be employees of the smelter and the plant's facilities would also be used for their training. During the long academic holiday they would work at the smelter, replacing people on leave in jobs commensurate with their level of training.

Although it is obviously to the smelter's advantage to start the technical school as early as possible, it should not be established until after start up. The construction and start up periods are very hectic, people do not know very well where they stand, and the atmosphere is not really conducive to the orderly training of personnel. The initial group of foremen and skilled workers will have to be trained abroad and returned to the smelter before the start up of their respective sections; a second group will be trained on the job, both by those who compose the first group and by the expatriate personnel. The training school can begin to operate in conjunction with the beginning of the first academic year after metal production begins.

For the positions of senior supervisors and managers the smelter will hire relatively young engineers--30 to 35 years old--and will send them to a foreign smelter for a period of two years, where they will receive specific training for the function they will eventually perform. In other words, each man will be trained so as to eventually replace a particular expatriate, next to whom the trainee will work when he returns to the smelter, until the replacement becomes possible.

It may not be possible to find engineers with sufficiently good background to be sent directly to a smelter abroad. In that case, it may be necessary to send younger men, first to complete their studies in a foreign university, and then transfer them to the smelter. In either case, the future senior supervisors and managers should be sent abroad for training as early as possible, even before construction starts so that at least some of them can return to the site previous to start up (construction can be expected to take in the order of 30 months).

At all levels more people should be trained than the smelter needs, since it cannot be expected that every trainee will stay. Some may go to other jobs, others will not make the grade. On the other hand, people should not be trained if there is no slot for them to fit into when the training is over. The proper balance between overtraining and undertraining has to be ascertained for each particular situation, and no general valid rule of thumb can be proposed.

Section 4.4 The Case of a More Developed Country (MDC)

This case can be treated very briefly since it is very much like the basic scenario, only better. The assumption is that the country has a labour force with the initial skills described in Section 2.4 and, in addition, it has at least one operating smelter. This means that some jobs at the new smelter can be filled by people who already have specific experience, that the existing smelter may be used for training some personnel for the new one, and that joint training programs can be developed. The extent of the cooperation between the smelters, or the extent to which the new one will be ready to lure people away from the existing one, will be highly dependent on their respective ownerships, and to some degree on their respective technologies. Since no general rules of behavior can be established, what we can say is that in the MDC case the training program will be the same as in the basic scenario, except that in those cases in which people with more than just the initial skills can be found, their training will be reduced accordingly, and in some cases all training may be waived.

Chapter 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Section 5.1 Summary

The aim of the present report is to give decision makers in the developing countries who have little previous knowledge of the aluminium industry, a clear picture of what could be called "the human input" in the operation of a smelter.

The report is centered on the problem of how many and what kinds of jobs are created by the establishment of a smelter, and what initial skills and further training are required for the people who will fill each one of these jobs. In addition, the report also touches upon a number of other factors concerning personnel that fall under the general category of "fringe benefits" (e.g., housing, medical care, schooling for dependents, etc.).

Since smelters vary over a fairly wide range of technologies and size, the manning schedule described in the report applies to one particular hypothetical smelter, and needs to be adjusted to any real situation. Three different scenarios are described for training schedules, but again it is unlikely that a real situation will fit one of the three exactly. Therefore, this work cannot be used in lieu of a feasibility study as far as labour requirements are concerned. Its usefulness is restricted to the pre-feasibility and decision making stages, and as a source of information to newcomers to the aluminium industry.

The report is based on information received from about thirty smelters around the world, of which six were visited, plus the previous experience of the author in smelter planning and construction in Latin America. The information was gathered by sending questionnaires and talking to officers of companies who operate smelters. In general, the response to both the written and verbal questions was very generous and, obviously, costly to the companies. Needless to say, the report owes its existence to the cooperation received from the producers.

The report is divided into five chapters. The first chapter is devoted to providing some background data on smelters and aluminium production that are considered to be of possible interest to planners in developing countries.

Two salient points should be mentioned here. One is that the developing countries have been steadily increasing their share of world primary aluminium production, from 1.57% in 1957, to 9.35% in 1977 (actually, it exceeded 10% in 1976 and 1977, and it is expected to exceed 10% again in 1978). The increase in share will continue since most of the production capacity to be added until the end of 1983 (2.6 million tonnes from a world total of 3.2 million) will be built in developing countries. Aluminium is, then, one industry where the target of the Lima Declaration may be reached.

The other point has to do with the use of labour in smelters. In developed countries, the annual output of metal per employee is found to increase very rapidly with smelter size, from about 120 tonnes at 75000 tonnes per year capacity, to about 175 tonnes at 150000 tonnes per year capacity. From our limited data it appears that the same is not true in developing countries where the increase of output per employee with smelter size is very slow. This fact, plus the higher fringe costs of labour in developing countries--such as housing, schools, hospitals, transportation, meals--reduces the labour-cost advantage of large smelters in such countries.

The second chapter describes a smelter that corresponds approximately to one that could be designed today for a developing country. For such a smelter, a complete organization chart is provided, with descriptions of about one hundred different jobs that are specific to the aluminium industry. Table 11 gives a breakdown of the 1625 employees in the proposed smelter, by department and by skills. The annual output by employee turns out to be about 74 tonnes, a conservative but realistic number, particularly, during the first years of operation. The chapter also includes the initial skills that people who are hired to fill these jobs should have, as well as the additional skills that they are expected to acquire through training.

The third chapter begins with a brief description of the physical facilities of the six smelters visited. These smelters were chosen so as to cover as wide a spectrum of geographical location, degree of development of the country, and technology utilized as possible (see Table 10 on page 88). The chapter continues with a description of the training experiences and programs

Table 11

Distribution of Personnel in the Proposed Smelter

Skills / Division	Managerial	Secretarial and Clerical	Sr. Supv. & Professional	Supervisory	Hourly Workers	Totals
Plant Management	2	7	1	-	-	10
Production Management	1	1	-	-	-	2
Reduction	-	4	4	24	248	280
Carbon	-	4	4	40	122	170
Cast-House	-	9	4	26	124	163
Production Services	-	4	4	15	104	127
Maintenance	1	5	3	35	430	474
Technical	1	10	21	4	12	48
Development & Engineering	1	5	40	-	-	46
Traffic	1	38	3	8	55	105
Industrial Relations	1	68	4	12	-	85
Administration	1	95	7	12	-	115
TOTALS	9	250	95	176	1095	1625

at the six smelters. Again we find a wide spectrum of situations, particularly in regard to the number of expatriates and the importance given to the training activities.

The fourth chapter is devoted to training programs. Three different scenarios are described. The so-called basic scenario corresponds to a country with a certain degree of industrialization, including some heavy industry, but with no experience in aluminium smelting. For this scenario the report presents descriptions of appropriate training programs for thirty nine different positions at the plant. It is recommended that forty three persons be sent abroad for training in a smelter of similar technology (in some cases, brief visits to more than one smelter are necessary). The training program proposed calls for 231 man-months in foreign facilities, on the assumption that no foremen and no hourly workers will be trained abroad. About one third of the man-months of foreign training corresponds to shift supervisors, and the rest to senior supervisory and managerial personnel.

After describing in considerable detail the basic training program, the report considers alternative programs for the more and less industrialized countries in the developing world. The report ends with recommendations to UNIDO and to developing countries planning to build a smelter.

Section 5.2 General Conclusions

It may not be out of place to begin the general conclusions by stating an obvious truth: smelters consist of buildings and equipment, but they are operated by people, and the people that operate them have to possess certain skills. Anybody with half a billion dollars in the bank can buy himself a good size smelter and have it delivered in about two years, all set to produce metal. Given a completely free hand, most contractors will even guarantee certain performance parameters for the equipment installed. But no reasonable (or even unreasonable) amount of money will produce an "instant" labour force, both skillful and stable, to run the smelter. Planners tend to talk about investments in terms of money only, and often forget that other crucial ingredient, namely, time. In the same way that in the physical world nothing can move faster than the speed of light, in the world of economic development very few things can move faster than the speed with which people can acquire skills. Teaching a child to learn to play the violin may cost his parents 3000 dollars (15 dollars per lesson, fifty lessons per year during four years), but the child will not learn to play the violin in one month simply because the parents have the 3000 dollars in the bank and are ready to spend the money.

Some current experiences in "explosive development" in certain countries of the world are tragic examples of what happens when the time element is neglected: what takes place is the explosion, not the development. Without going to such extremes, the point to be made is that the acquisition of a skilled and stable labour force can be a much slower, delicate and unpredictable process than the acquisition of hardware. This is particularly true of the upper echelons of the labour force (managers and senior supervisors), who compound the complexity of the problem because they are responsible for the training and supervision of everybody else. In a nutshell, as a first general conclusion what can be said is that the question of who is going to operate the smelter, at all levels, should be investigated in far more detail than has been done in most developing countries in the past.

Moving now to more specific points, the following will be briefly noted.

Most smelters built in developing countries require the relocation of at least some workers. This is always difficult and leads to large turnover rates. If a worker has a nomadic nature, (e.g., construction workers) chances are that he will not stay long in any one place; if he has a very sedentary nature, he may not be able to cope with the relocation and will return home. Hence, only a small percentage of the people relocated can be counted on to stay and settle in the area permanently.

Some smelter sites require the construction of a company town. They seem to create many problems and are very difficult to manage. On the other hand, good housing and other social benefits for the personnel and their immediate dependents are the major antidotes against the ills generated by relocation.

Finally, one more observation addressed to those who plan, and those who will manage, a new smelter. Suppose the smelter has about 400 pots. When asked how long it takes to reach full production after the first pot is energized, the technology supplier may give an estimate of about eighteen months, a little more or a little less according to the local circumstances. This estimate, which in practice is very likely to prove correct, is not to be taken, however, as the time required for the smelter to reach stable operation. Running a smelter is never a totally routine operation; even in fairly mechanized installations the human factor plays a role, and it will take several years after the last pot is added to the series before the labour force learns to "feel" the optimum operation of the plant. Furthermore, since the original linings of the pots will last a minimum of three years, a routine relining schedule also takes some years after the completion of start up before it becomes established. Therefore, one should be prepared to wait a consolidation period of at least five years after first metal is produced before the labour force adjusts itself to its final size and all work norms and procedures are definitely established.

Section 5.3 Recommendations to the Developing Countries

The following recommendations are believed to be applicable to any developing country planning to build a smelter.

a) Include an in-depth survey of the local labour market in the feasibility study of the smelter. The job descriptions and lists of initial skills given in this work can provide the guidelines for the survey. If the labour market in the immediate vicinity of the plant cannot provide all the required skills, extend the survey to other parts of the country and to neighbouring countries that may provide personnel. In the survey try to ascertain the number and skills of the required expatriates, if any.

b) If several sites are possible, try to select the one that will minimize the need to import labour. Avoid relocation of workers as much as possible.

c) If possible, avoid the construction of a company town. If housing has to be provided for a large number of workers, build small apartment blocks in different parts of the town so as to integrate the smelter personnel to the already existing community.

d) Provide good medical facilities for the workers and their families. Provide sport facilities and other social amenities. Try to build a strong company image.

e) If other large companies are operating in the neighbourhood of the future smelter, look carefully at the history of their labour relations and the kind of image they have developed.

f) Give top priority to the preparation of detailed job specifications. This should be completed before any hiring is done. Failure to prepare job specifications in advance was considered the worst mistake that had been made by the company by the personnel managers of two of the plants visited.

g) Identify local preferences for employment. Be sure that employees will accept shift work.

h) Study the possibility of employing women in a large variety of jobs. Up to now very few women have been hired as hourly workers in smelters, but for no apparent reason. In an area of large turnover, the employment of women will help to stabilize the labour force.

i) Differentiate clearly the different stages of the project: construction, start up, consolidation, routine operation. Keep in mind that very seldom can construction workers be retrained to work in the smelter, and that excess manpower has to be accepted during start up and consolidation. Clearly set the target dates when a steady work force must be reached by each department, and for the replacement of each expatriate.

j) Be sure that enough funds are earmarked for training, and that sufficient lead times are allowed. Have the training superintendent interact permanently with the heads of the plant's departments. Training cannot become an end in itself. In particular, avoid the formation of elite trainees, and do not train if there are no vacancies available.

k) Introduce a system of initial assessment of employees by means of intelligence and other tests. Measure their level of achievement with a view towards promotion. If possible promote from within the ranks; do not hire a person for an upper slot if somebody at the plant can be trained upwards. Always try to leave yourself room at the top.

l) In preparing job specifications be careful not to overrate the job. Do not call for an engineer if a technician can do the job. Overtraining will result in the man's dissatisfaction with his work.

m) Avoid automatic promotions through seniority. The promotion policy of the company should be made known to the new employee, either through a brochure or spelled out in the letter of appointment.

Section 5.4 Recommendations to UNIDO

Action to UNIDO can be recommended in three general areas:

a) UNIDO should provide assistance, mainly in the form of experts, to allow the developing countries to carry out those recommendations made to them in the previous Section for which no local expertise is available. In particular, assistance could be provided for the following tasks:

i - to carry out labour market surveys. Two experts, one in aluminium and the other in industrial relations, can advise a local team on two areas, one dealing with the quantity and quality of the personnel required by the smelter being planned, the other dealing with the mechanics of the survey itself. The survey should not only count heads and skills but also look into the composition of the population, its local habits, the possibility of training its members to do shift work. It should evaluate the attractiveness of the area to outsiders and its potential for improvement; it should identify problem areas, such as lack of proper medical attention, possible overcrowding of schools, etc.

ii - the preparation of detailed job specifications. This may require a team of as many as four people, each one with very detailed knowledge of one area of the plant (potrooms, including relining and other production services; carbon plant; cast house and laboratory; maintenance). On the other hand, it may be possible to have it done by one person on the basis of information provided by one or two companies. Another solution is to contract it as one of the services to be provided by the supplier of technology.

iii - the preparation of training programs. In this area the collaboration and good will of the supplier of technology is indispensable, but it is not enough. The developing country planners will also need independent advice, free from unilateral constraints.

Such freedom is required in order to develop comprehensive training programs that reconcile the different views on training which may be held by the department heads, by upper management, by government officials and by the technology supplier.

b) UNIDO should assist in establishing channels of communication between those developing countries planning to enter into the field of aluminium smelting, and those with smelters already in operation. The latter may be able to provide assistance to the former in the area of personnel in one or more of the following ways:

i - by making available information on their own job descriptions, training programs, and general experience with their own staff.

ii - by allowing some of their staff members to transfer temporarily to the new smelter to assist in either training or operating activities.

iii - by accepting personnel from the new smelter as trainees.

All three of the above services can and should be provided by the technology supplier. The advantages, however, of interaction with another smelter in a developing country can be: lower cost of the services; better communication from the point of view of language, cultural patterns, social outlook; similarities in the type of problems encountered in areas such as maintenance, materials handling, infrastructure, as well as in general climate (both meteorological and social). Because of these advantages, such interaction would be very desirable to the new smelter, but it should be complementary to, and not in substitution of, the services of the technology supplier.

c) If the present work turns out to be useful in helping developing countries in the design of manning and training schedules for aluminium smelters, UNIDO should consider its extension to other sectors of the industry--such as bauxite mining, production of alumina and fabrication--and to other metallurgical industries which are of great interest to developing countries, such as iron, from mining to raw steel production, and copper, from mining to smelting or refining.

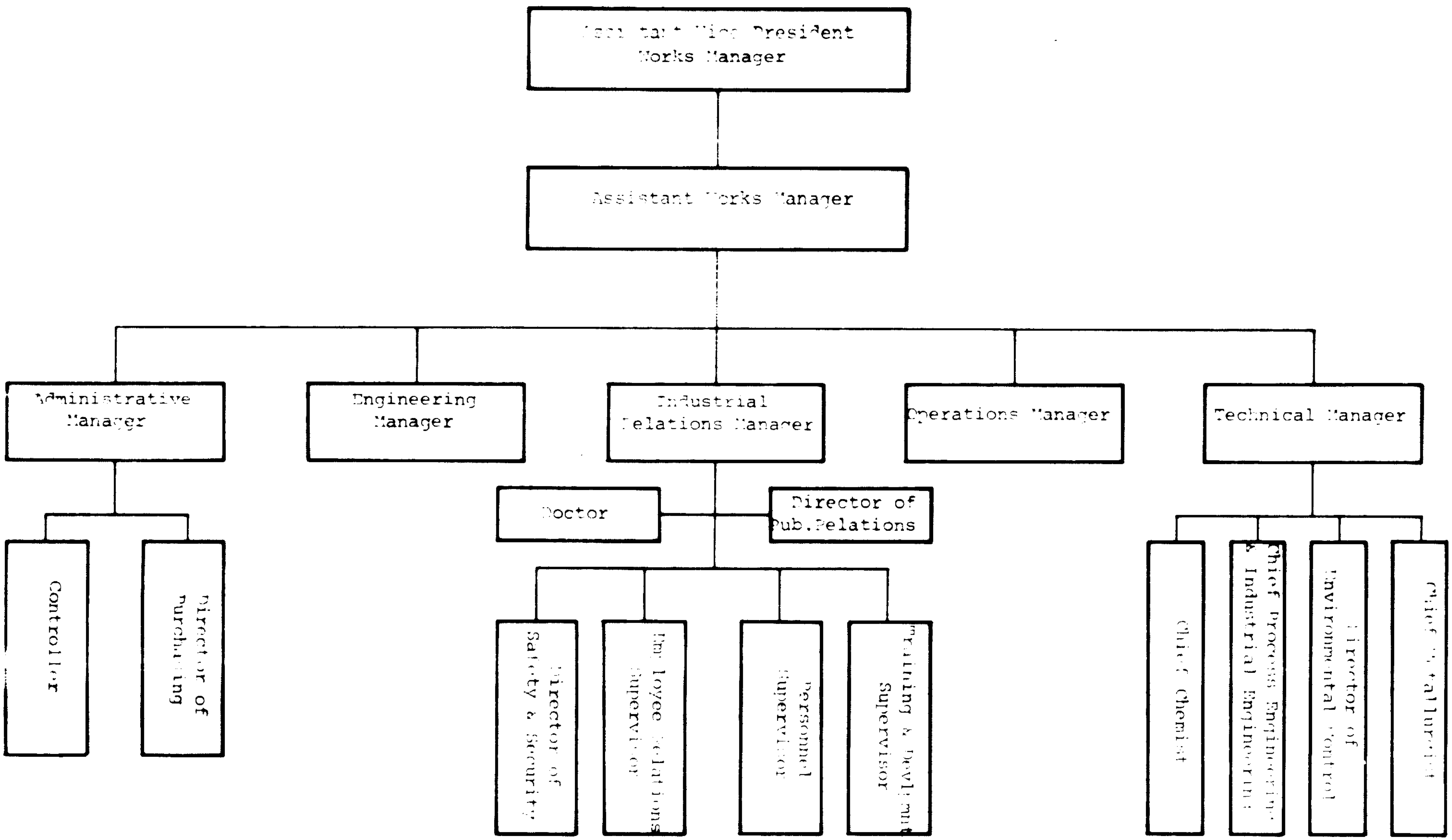
APPENDIX I

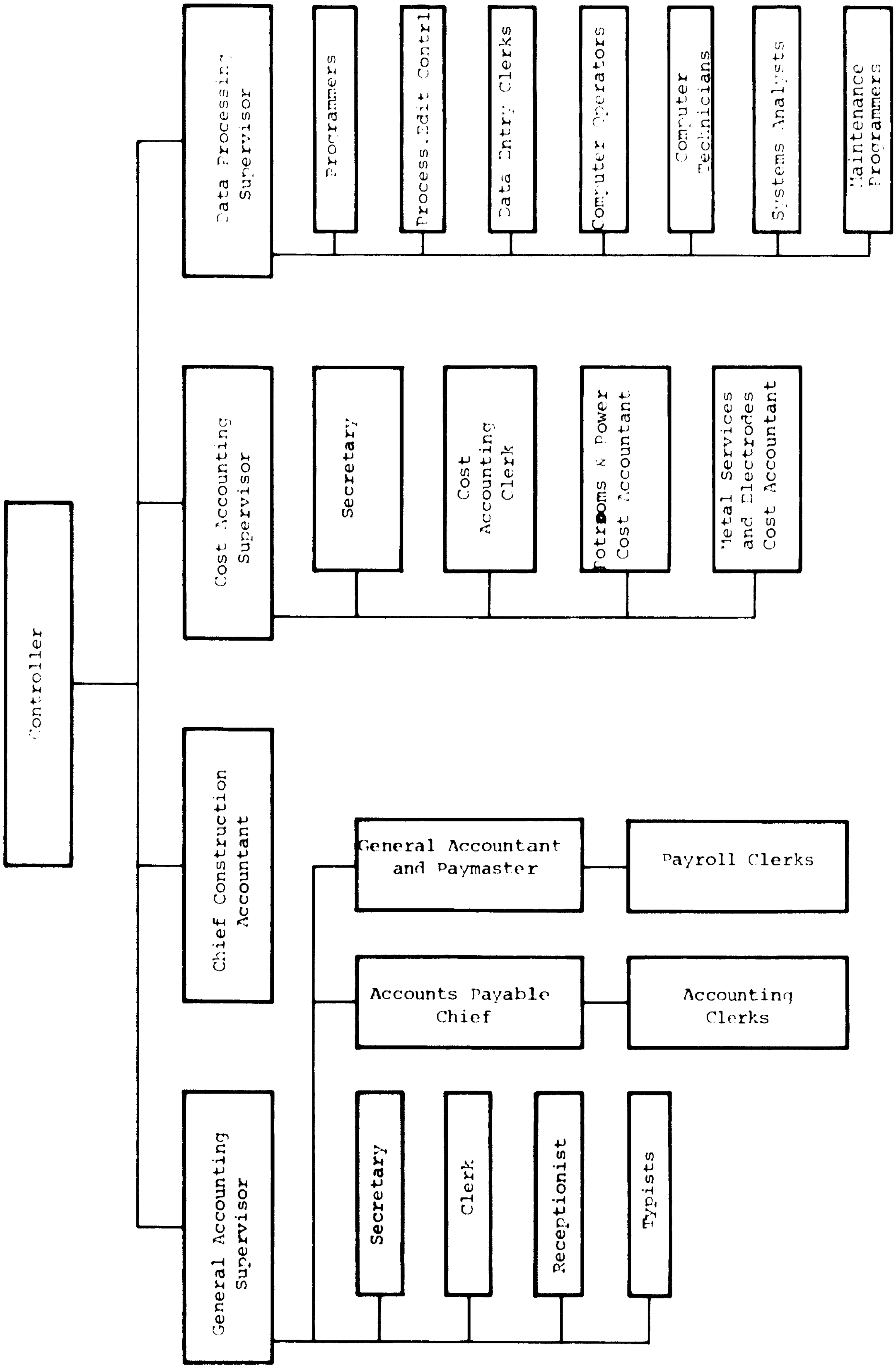
Firms From Which Information Was Received

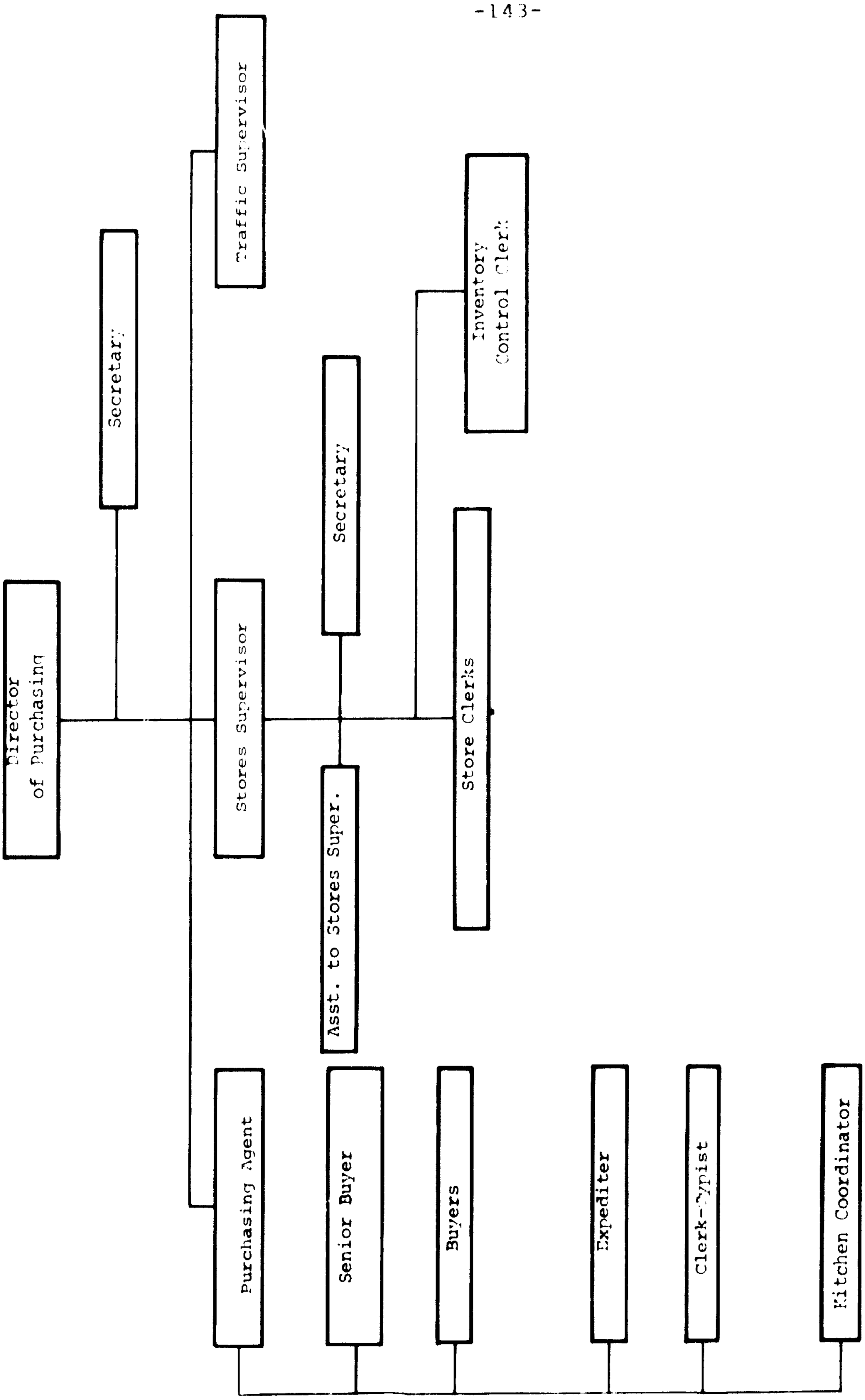
Alcan Aluminium Ltd. (Canada)
ALSAR (Sardinia, Italy)
Aluar Aluminio Argentino SAIC (Argentina)
Alumetal SpA (Italy)
Aluminio Español SA (Spain)
ALBA (Bahrain)
Aluminium Company of Egypt
Aluminum Company of America (U.S.A.)
Amalgamated Metal Corporation (U.K.)
Bharat Aluminium Company (India)
Companhia Brasileira de Aluminio (Brazil)
Companhia Vale de Rio Doce (Brazil)
Dubai Aluminium Company, Ltd. (United Arab Emirates)
Howmet Corporation (U.S.A.)
IRALCO (Iran)
Kaiser Aluminum & Chemical Corporation (U.S.A.)
National Southwire Aluminum (U.S.A.)
Pechiney Ugine Kuhlman (France)
Reynolds Metals Company (U.S.A.)
Showa Denko KK (Japan)
Swiss Aluminium Ltd. (Switzerland)
VENALUM (Venezuela)

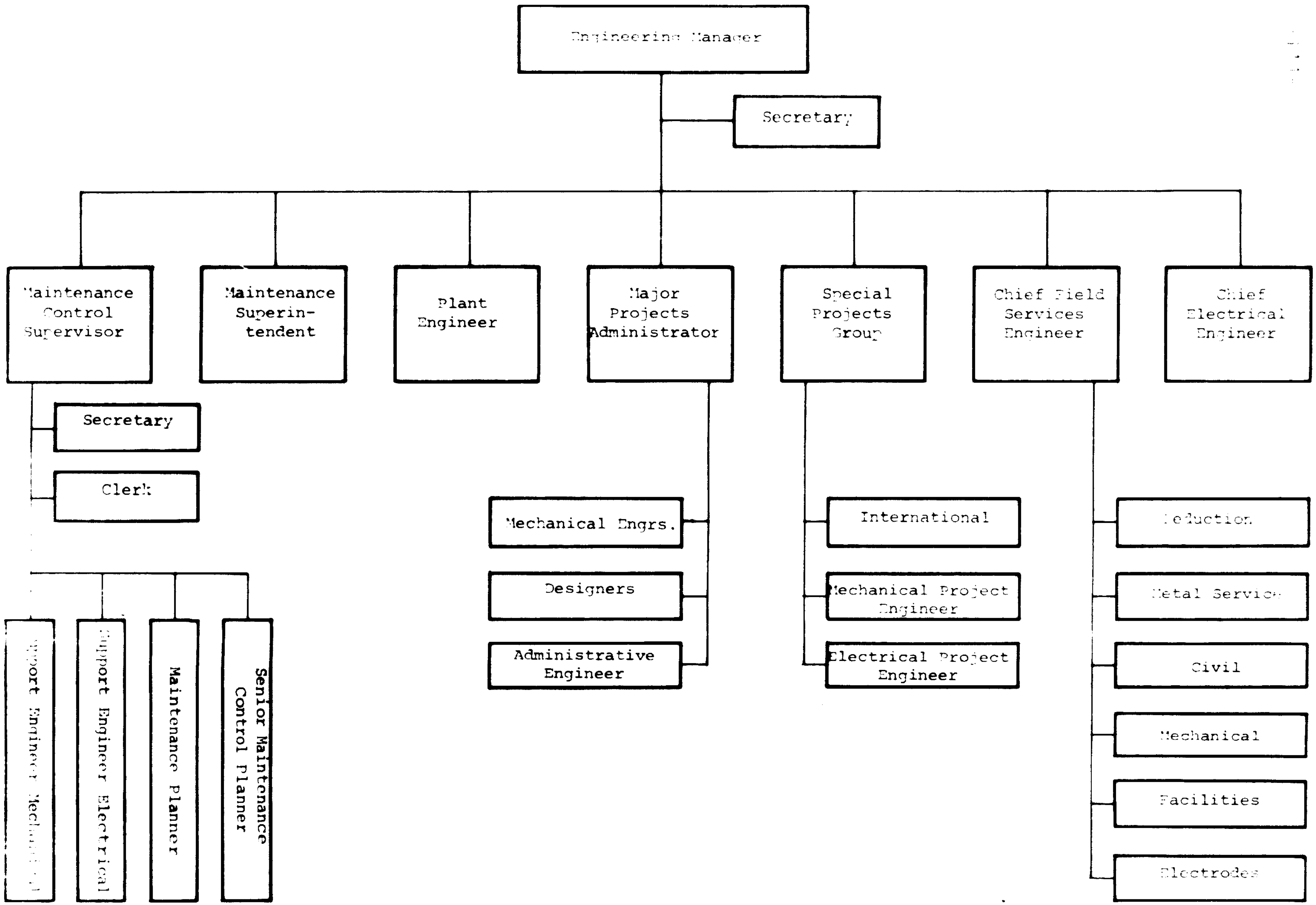
APPENDIX II

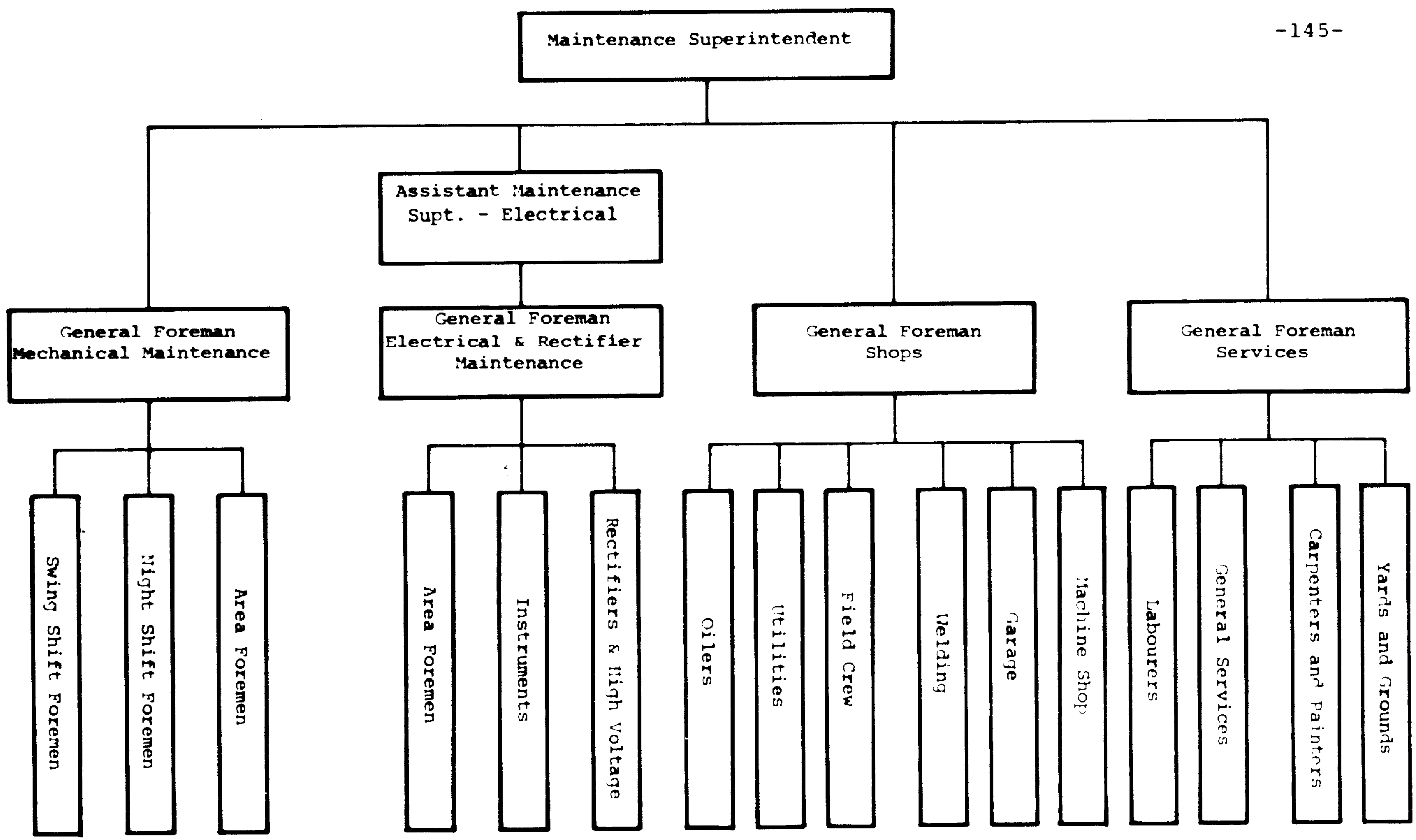
ORGANIZATION CHART OF A MODERN SMELTER IN A DEVELOPED COUNTRY

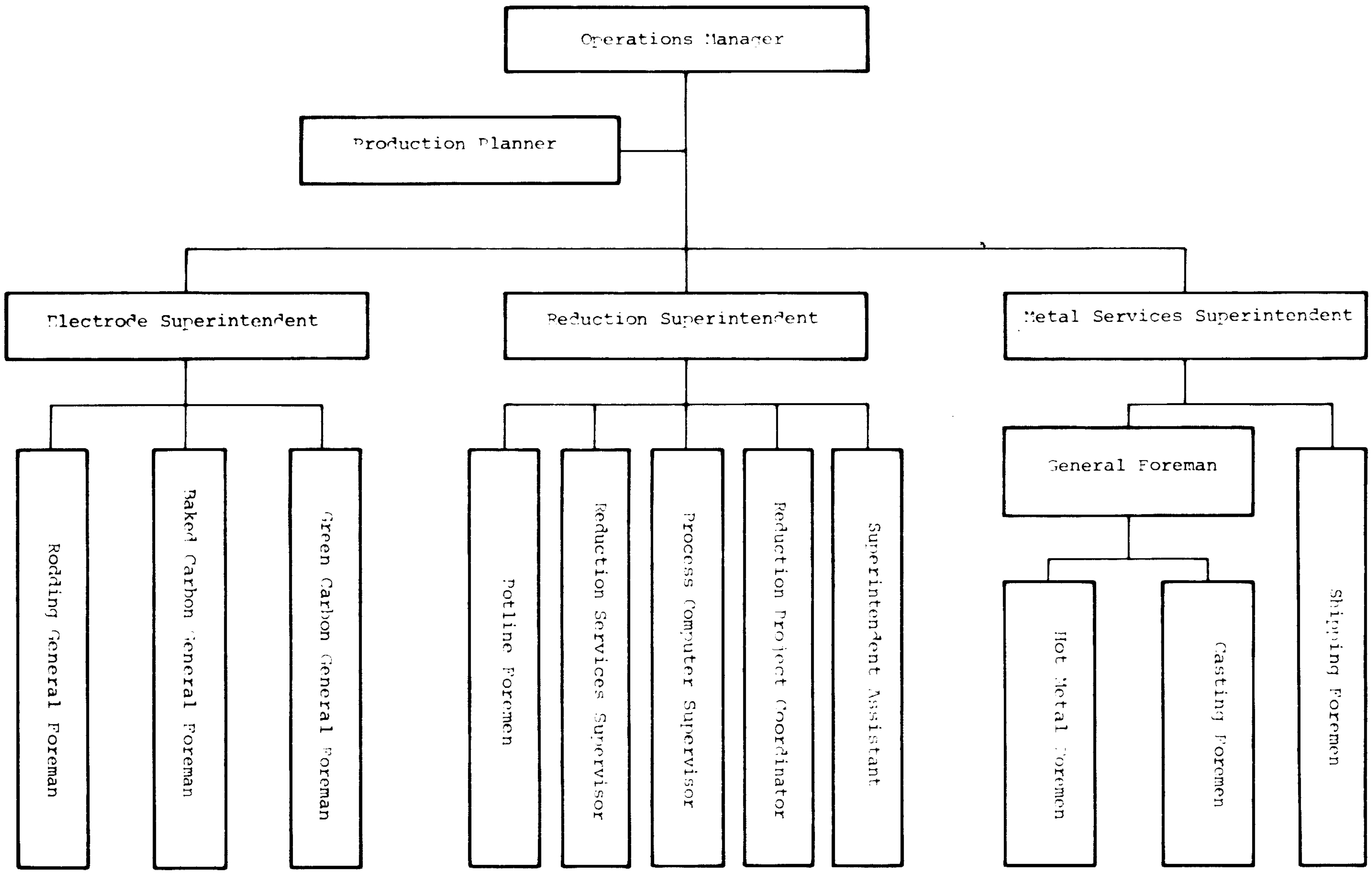


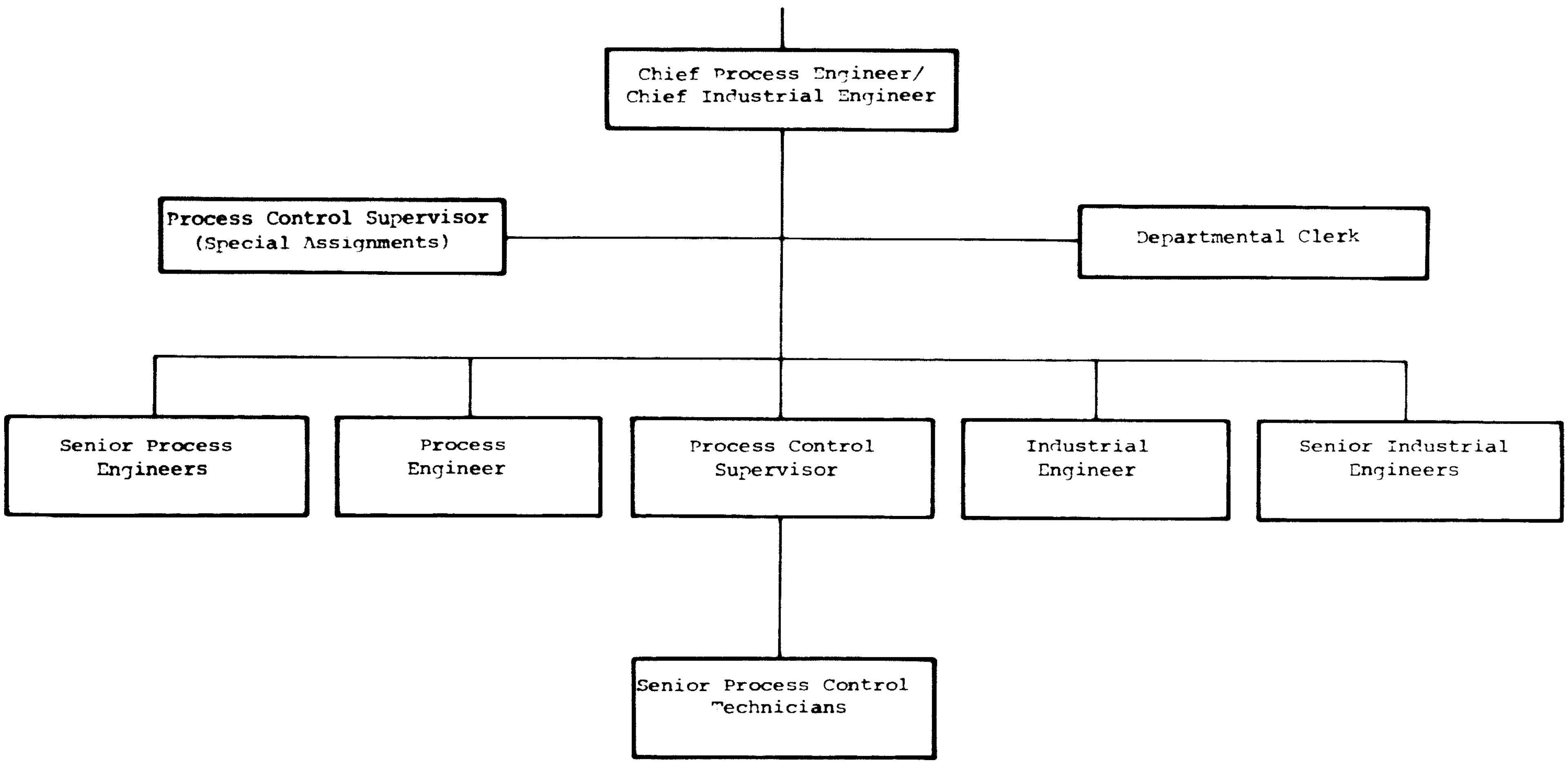

Controller
Data Processing Supervisor
Programmers
Process.Edit Contrl
Data Entry Clerks
Computer Operators
Computer Technicians
Systems Analysts
Maintenance Programmers
Cost Accounting Supervisor
Secretary
Cost Accounting Clerk
Potrooms & Power Cost Accountant
Metal Services and Electrodes Cost Accountant
Chief Construction Accountant
General Accounting Supervisor
General Accountant and Paymaster
Payroll Clerks
Accounts Payable Chief
Accounting Clerks
Secretary
Clerk
Receptionist
Typists


Director of Purchasing
Secretary
Traffic Supervisor
Stores Supervisor
Secretary
Asst. to Stores Super.
Inventory Control Clerk
Store Clerks
Purchasing Agent
Senior Buyer
Buyers
Expediter
Clerk-Typist
Kitchen Coordinator


Engineering Manager
Secretary
Maintenance Control Supervisor
Maintenance Superintendent
Plant Engineer
Major Projects Administrator
Special Projects Group
Chief Field Services Engineer
Chief Electrical Engineer
Secretary
Clerk
Support Engineer Electrical
Maintenance Planner
Senior Maintenance Control Planner
Mechanical Engrs.
Designers
Administrative Engineer
International
Mechanical Project Engineer
Electrical Project Engineer
Civil
Mechanical
Facilities
Electrodes

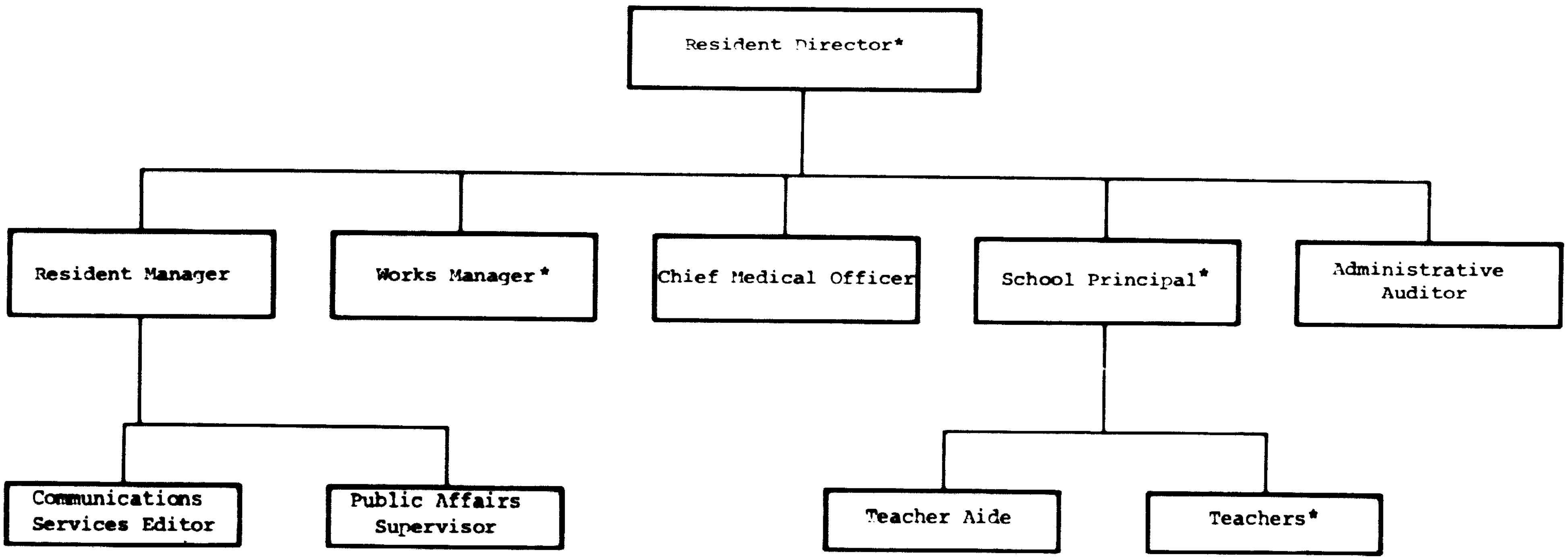

Maintenance Superintendent
Assistant Maintenance Supt. - Electrical
General Foreman Mechanical Maintenance
General Foreman Electrical & Rectifier Maintenance
General Foreman Shops
General Foreman Services
Swing Shift Foremen
Night Shift Foremen
Area Foremen
Area Foremen
Instruments
Rectifiers & High Voltage
Oilers
Utilities
Field Crew
Welding
Garage
Machine Shop
Labourers
General Services
Carpenters and Painters
Yards and Grounds


Operations Manager
Production Planner
Electrode Superintendent
Reduction Superintendent
Metal Services Superintendent
Rodding General Foreman
Baked Carbon General Foreman
Green Carbon General Foreman
Potline Foremen
Reduction Services Supervisor
Process Computer Supervisor
Reduction Project Coordinator
Superintendent Assistant
General Foreman
Hot Metal Foremen
Casting Foremen
Shipping Foremen

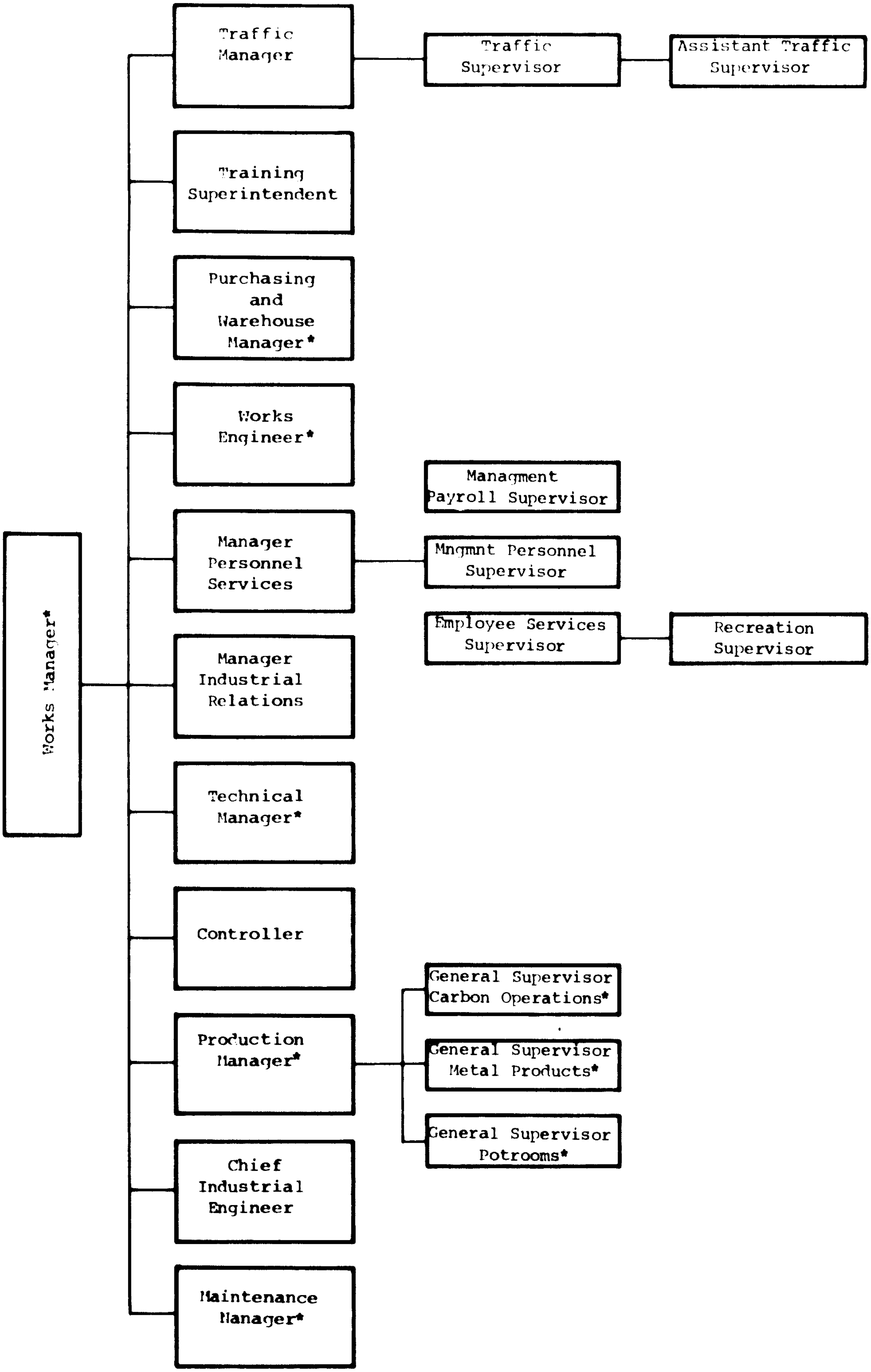

Chief Process Engineer/
Chief Industrial Engineer
Process Control Supervisor
(Special Assignments)
Departmental Clerk
Senior Process
Engineers
Process
Engineer
Process Control
Supervisor
Industrial
Engineer
Senior Industrial
Engineers
Senior Process Control
Technicians

APPENDIX III

ORGANIZATION CHART OF A MODERN SMELTER IN A DEVELOPING COUNTRY



*Expatriates



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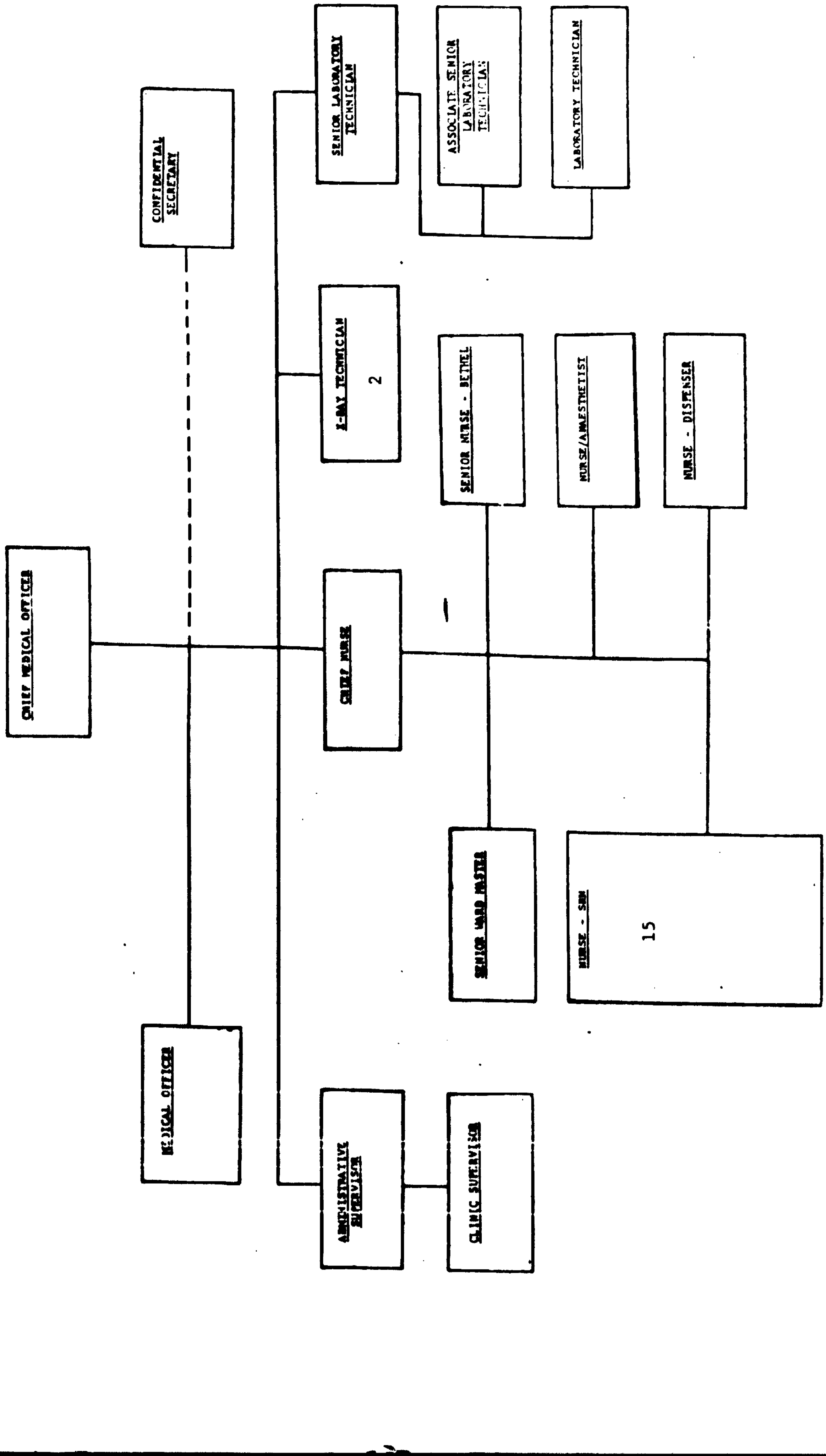
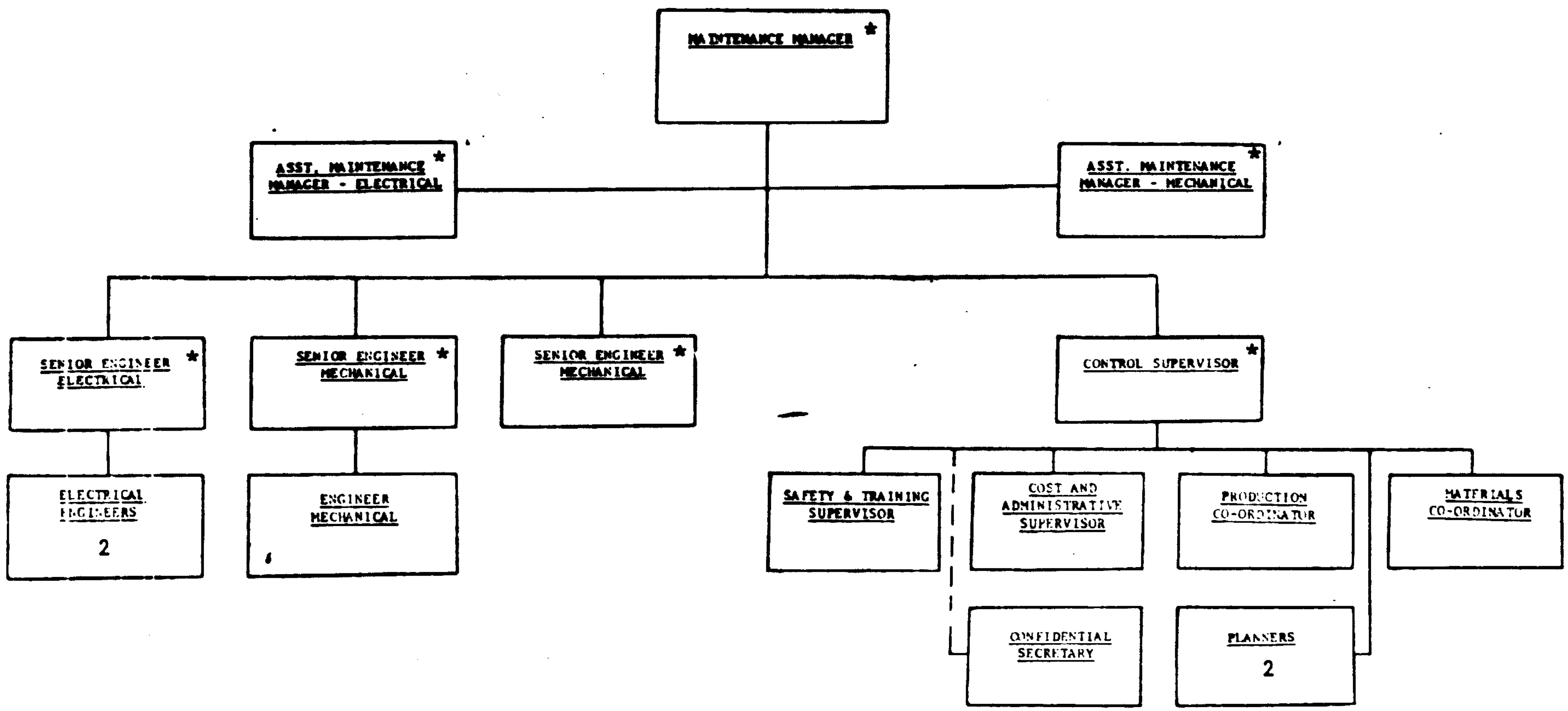

CHIEF MEDICAL OFFICER
CONFIDENTIAL SECRETARY
MEDICAL OFFICER
SENIOR LABORATORY TECHNICIAN
ASSOCIATE SENIOR LABORATORY TECHNICIAN
LABORATORY TECHNICIAN
X-RAY TECHNICIAN
2
CHIEF NURSE
ADMINISTRATIVE SUPERVISOR
CLINIC SUPERVISOR
SENIOR NURSE - BETHEL
NURSE/ANAESTHETIST
NURSE - DISPENSER
SENIOR WARD MASTER
NURSE - SRN
15



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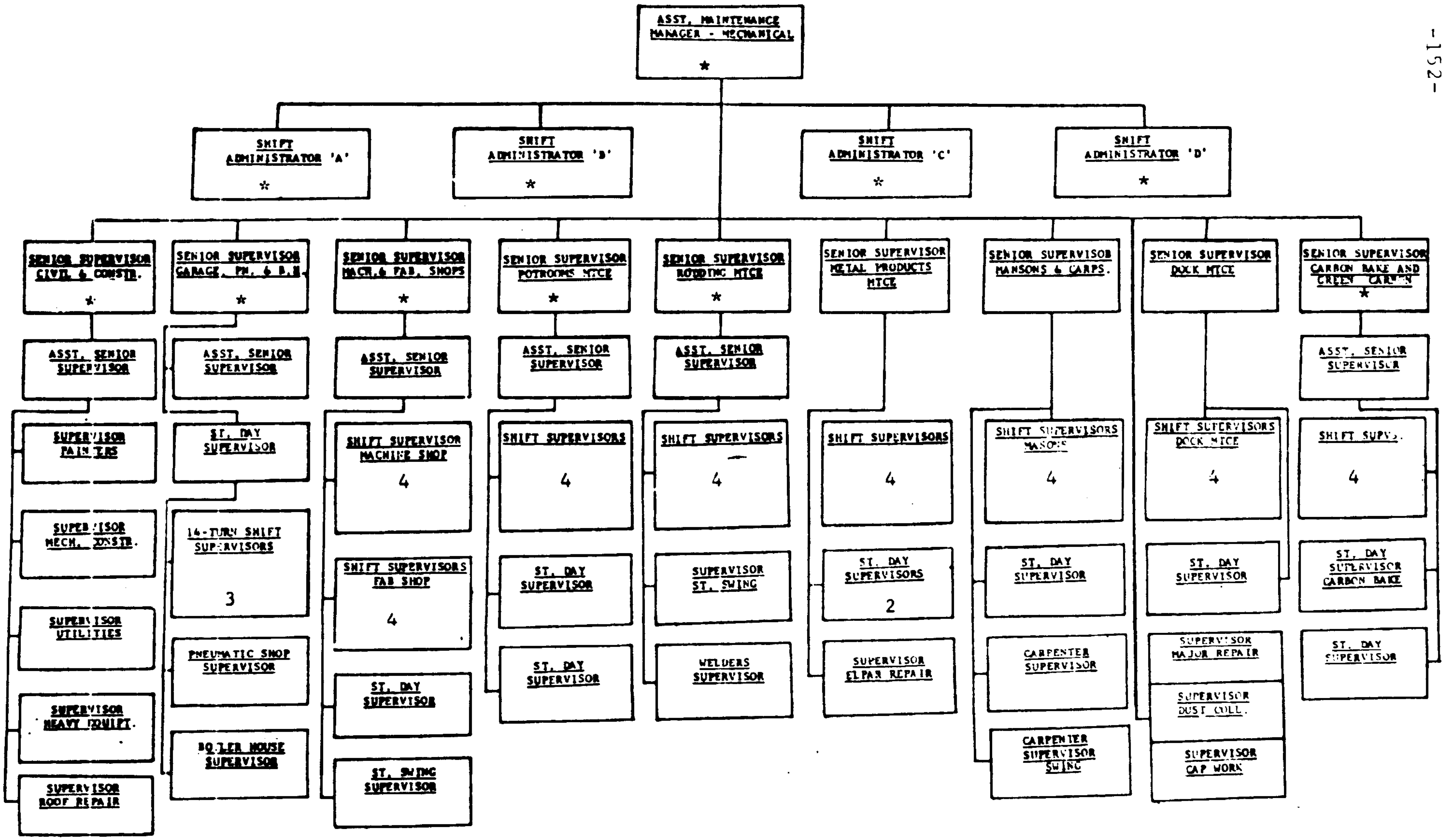

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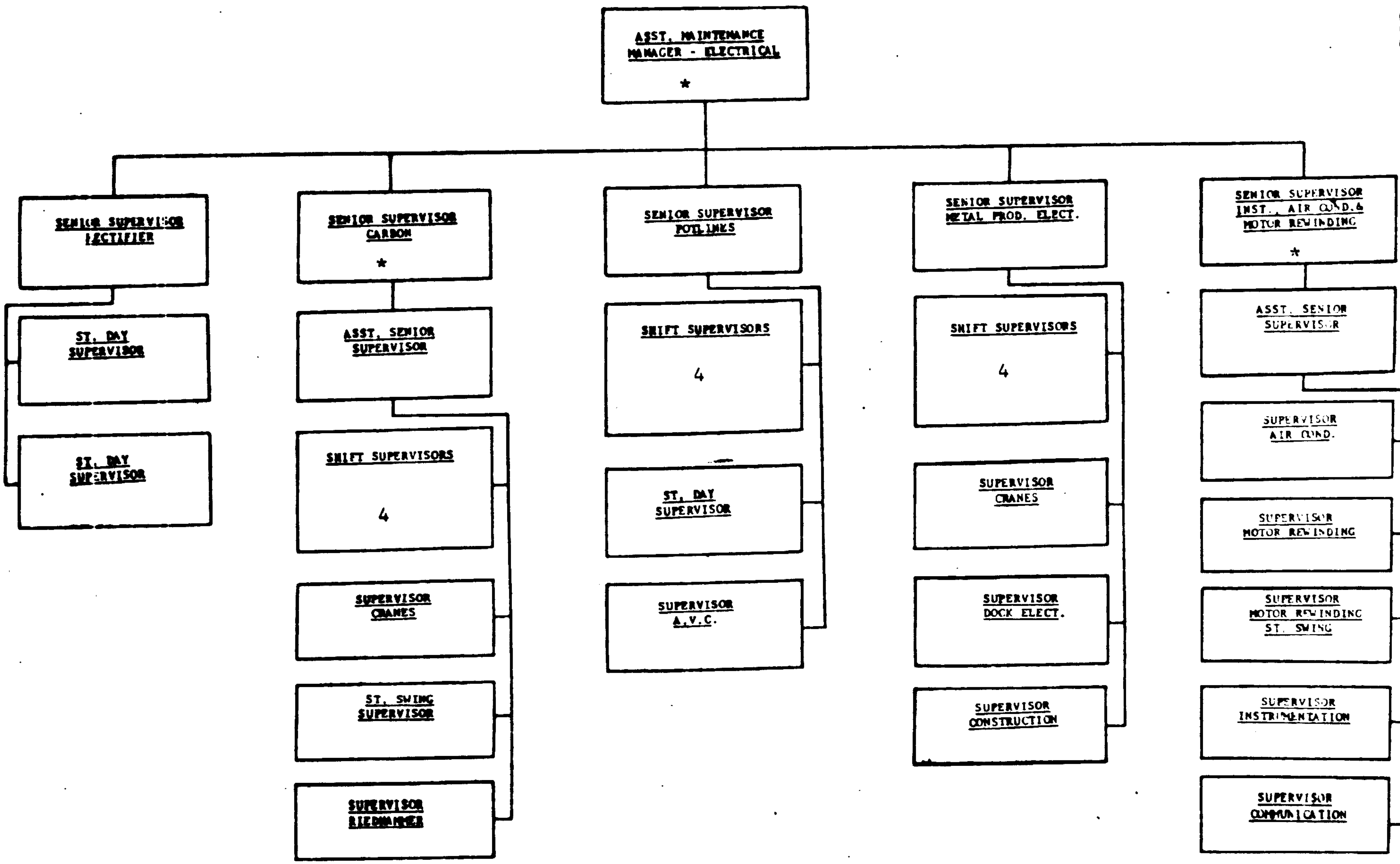

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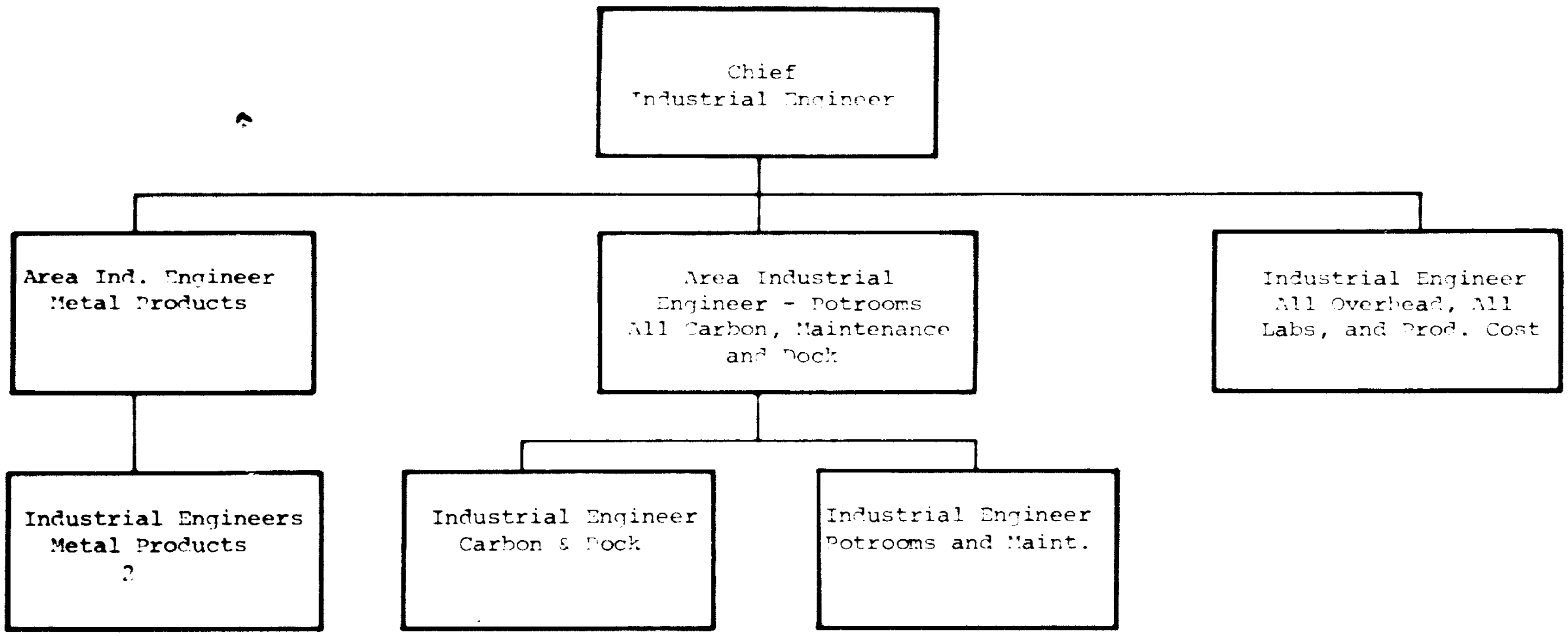
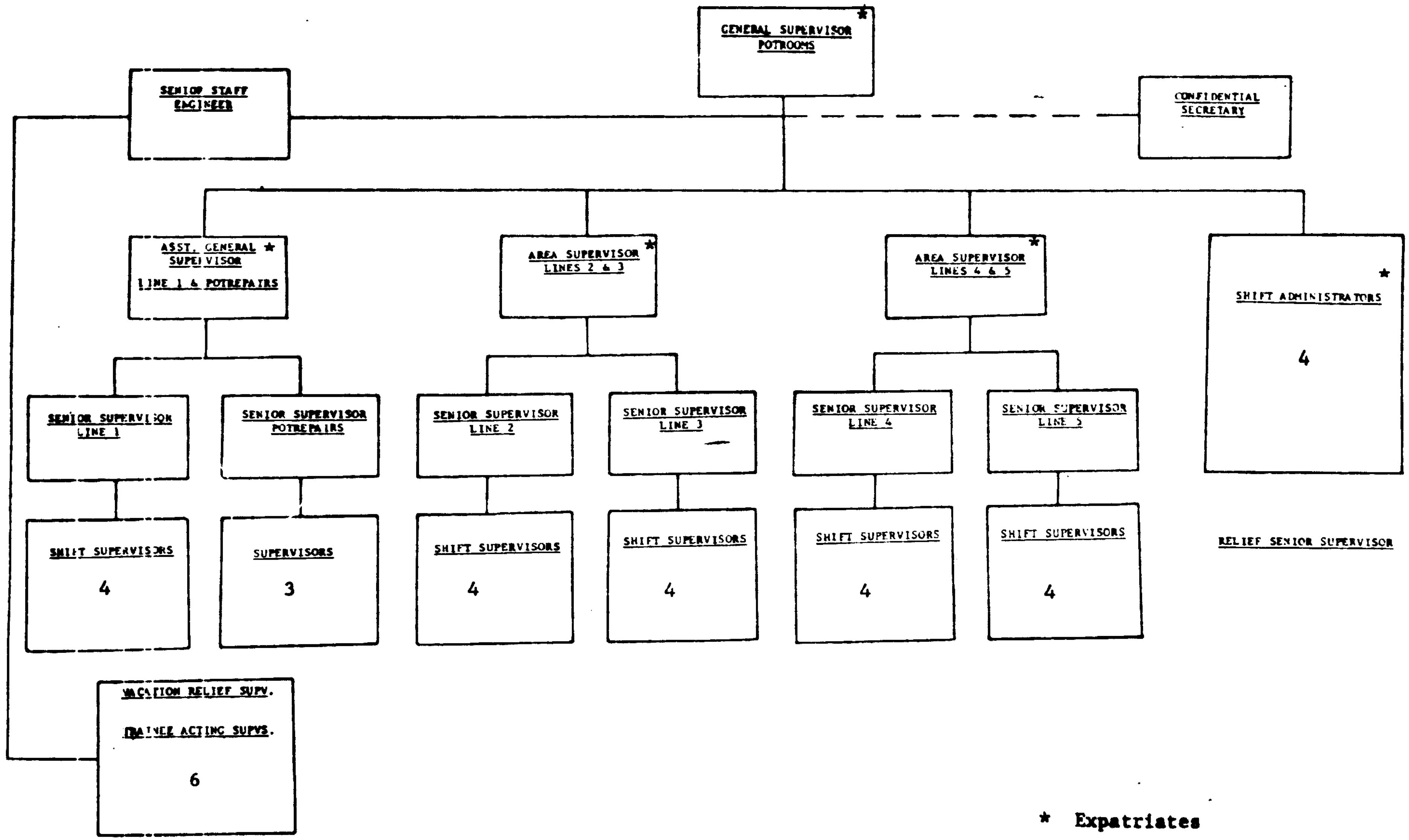

Chief
Industrial Engineer
Area Ind. Engineer
Metal Products
Area Industrial
Engineer - Potrooms
All Carbon, Maintenance
and Dock
Industrial Engineer
All Overhead, All
Labs, and Prod. Cost
Industrial Engineers
Metal Products
2
Industrial Engineer
Carbon & Dock
Industrial Engineer
Potrooms and Maint.



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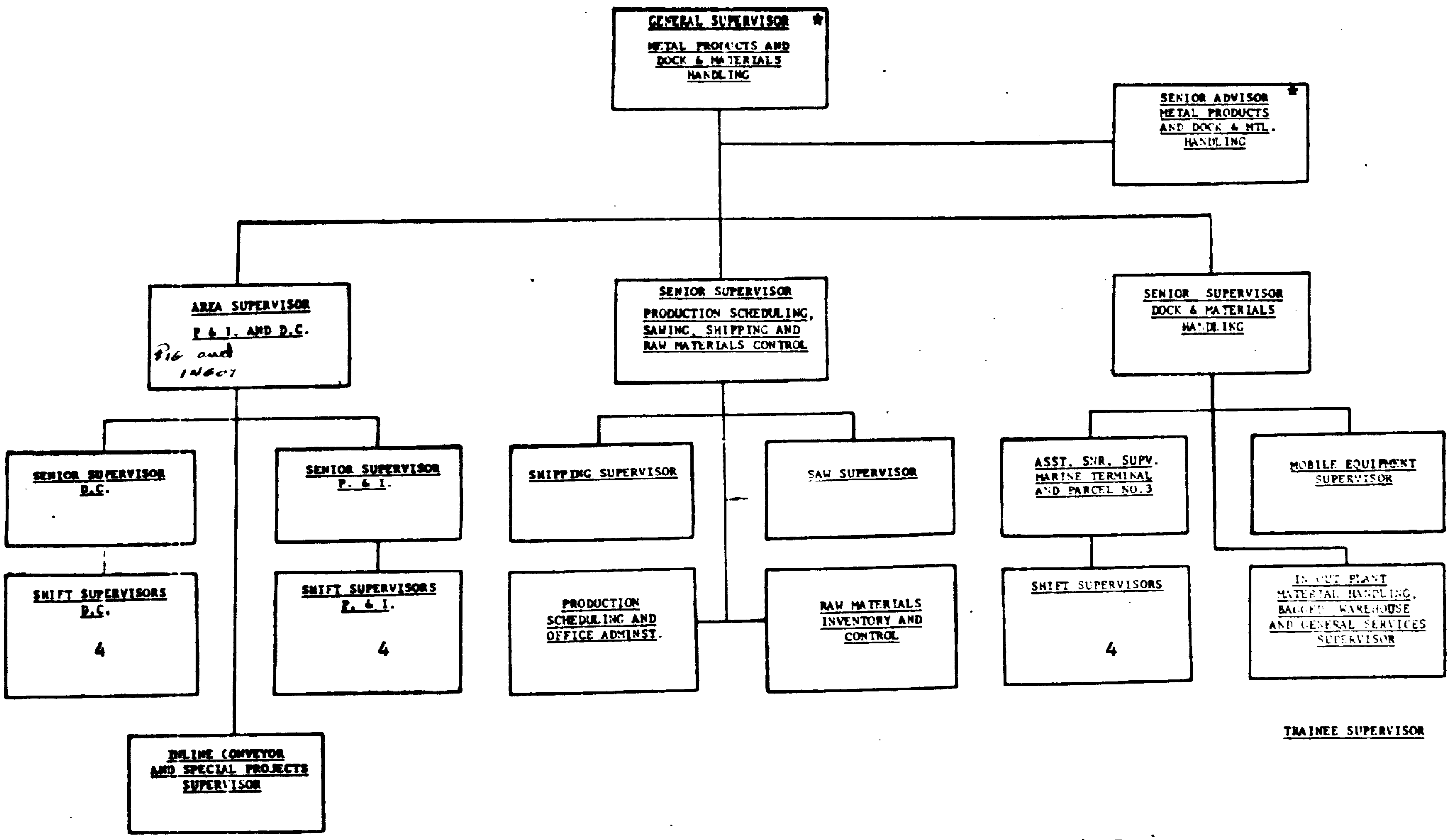

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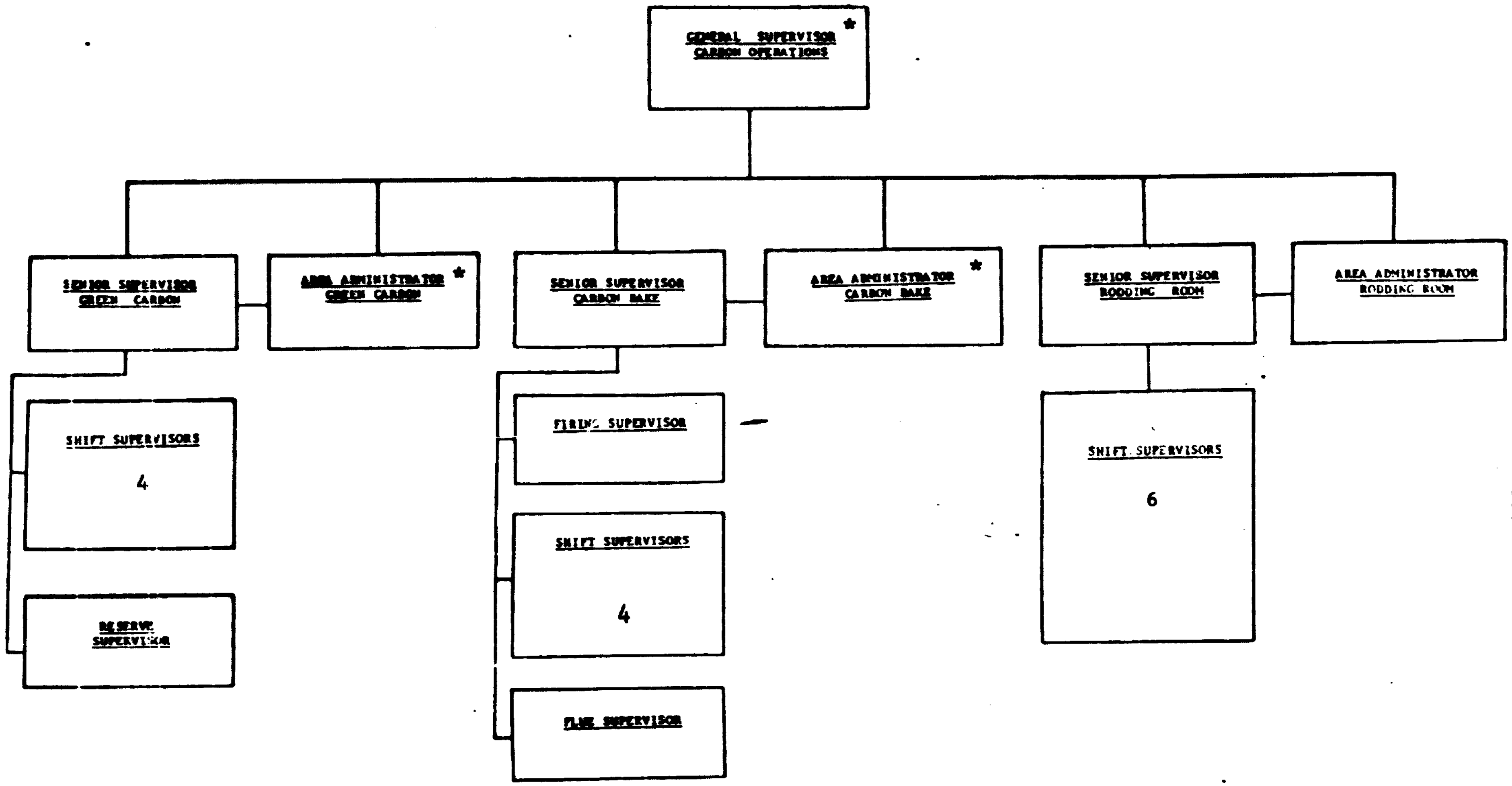

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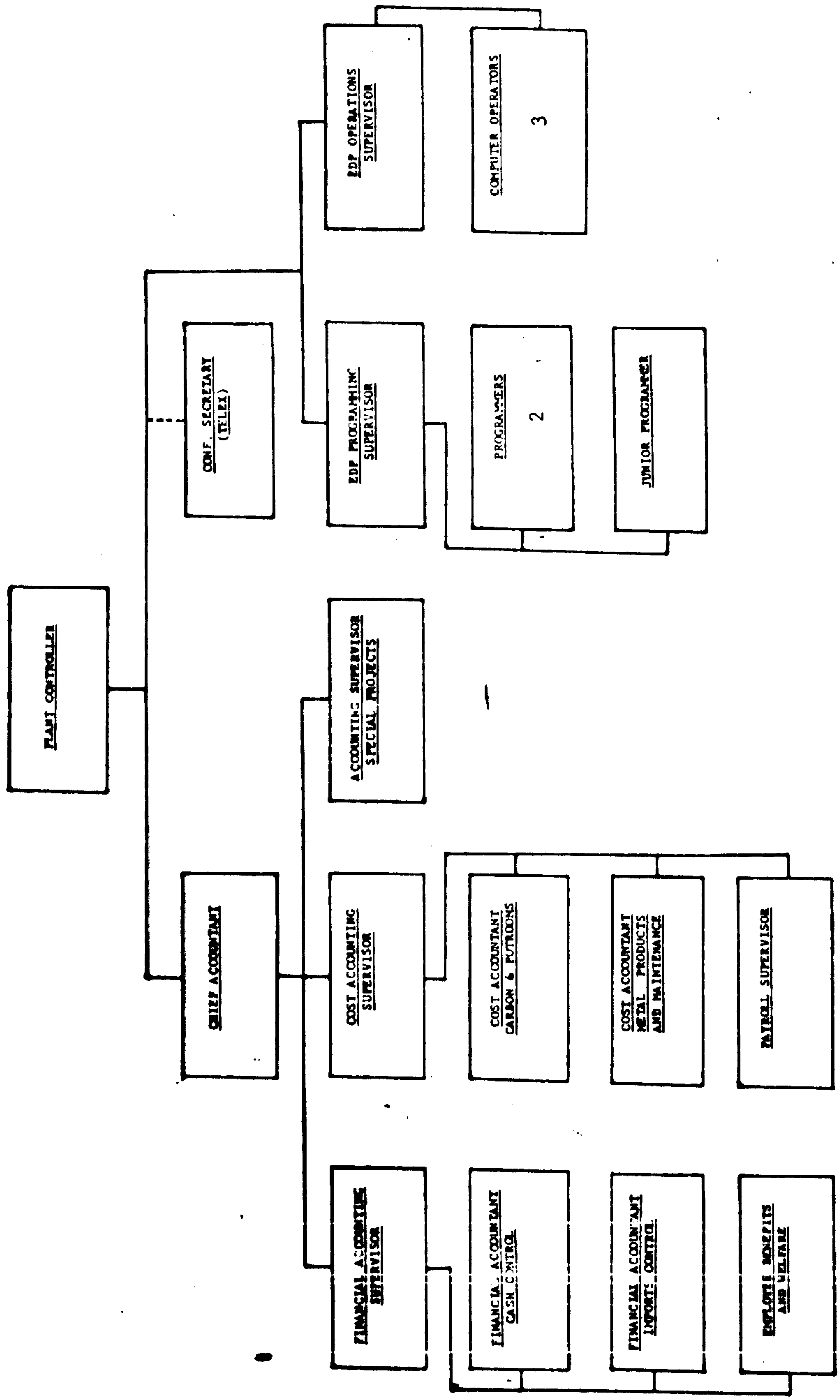
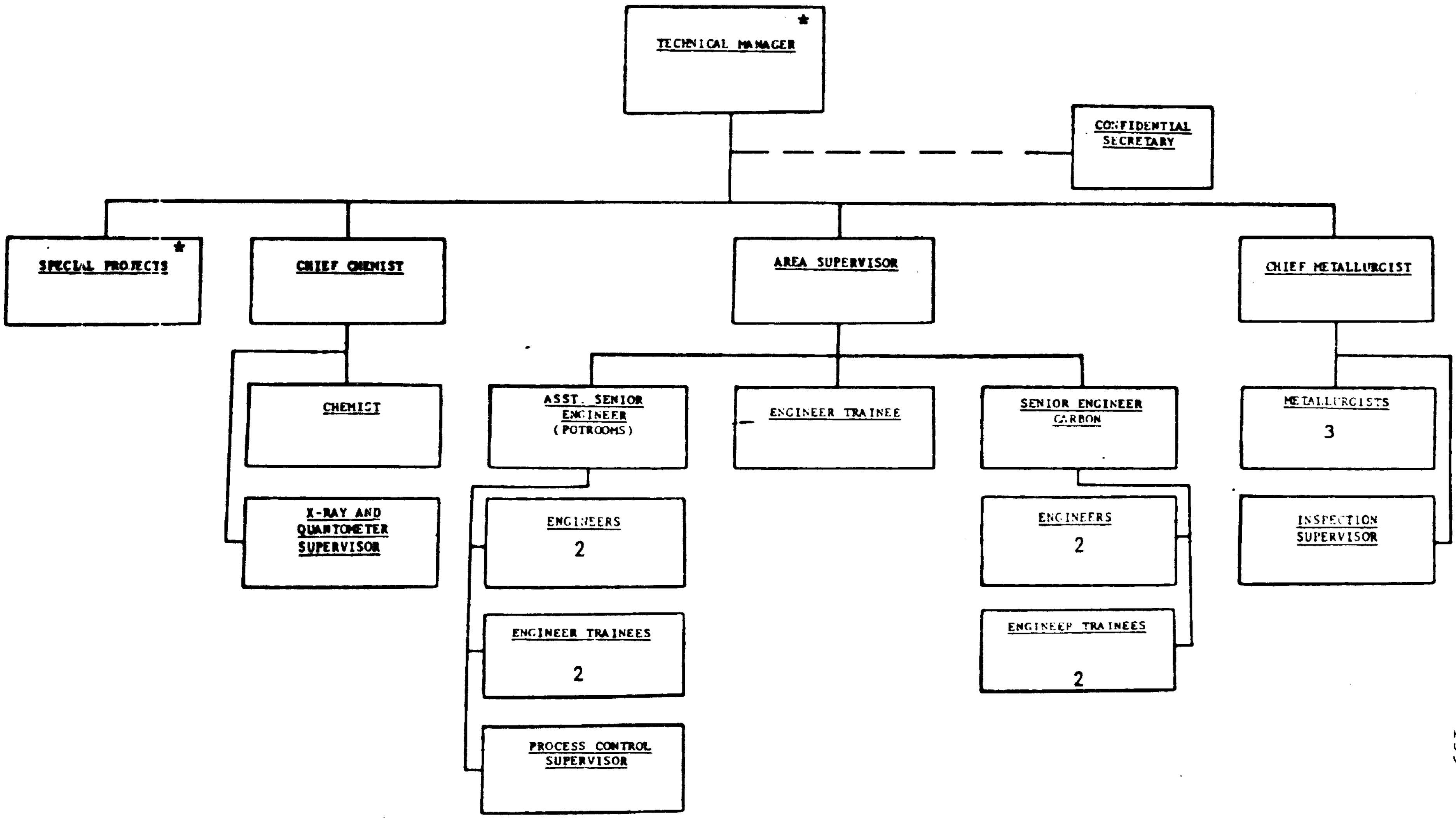

PLANT CONTROLLER
CONF. SECRETARY (TELEX)
EDP OPERATIONS SUPERVISOR
COMPUTER OPERATORS 3
EDP PROGRAMMING SUPERVISOR
PROGRAMMERS 2
JUNIOR PROGRAMMER
ACCOUNTING SUPERVISOR SPECIAL PROJECTS
CHIEF ACCOUNTANT
COST ACCOUNTING SUPERVISOR
COST ACCOUNTANT CARBON & PUTROOMS
COST ACCOUNTANT METAL PRODUCTS AND MAINTENANCE
PAYROLL SUPERVISOR
FINANCIAL ACCOUNTING SUPERVISOR
FINANCIAL ACCOUNTANT CASH CONTROL
FINANCIAL ACCOUNTANT IMPORTS CONTROL
EMPLOYEE BENEFITS AND WELFARE



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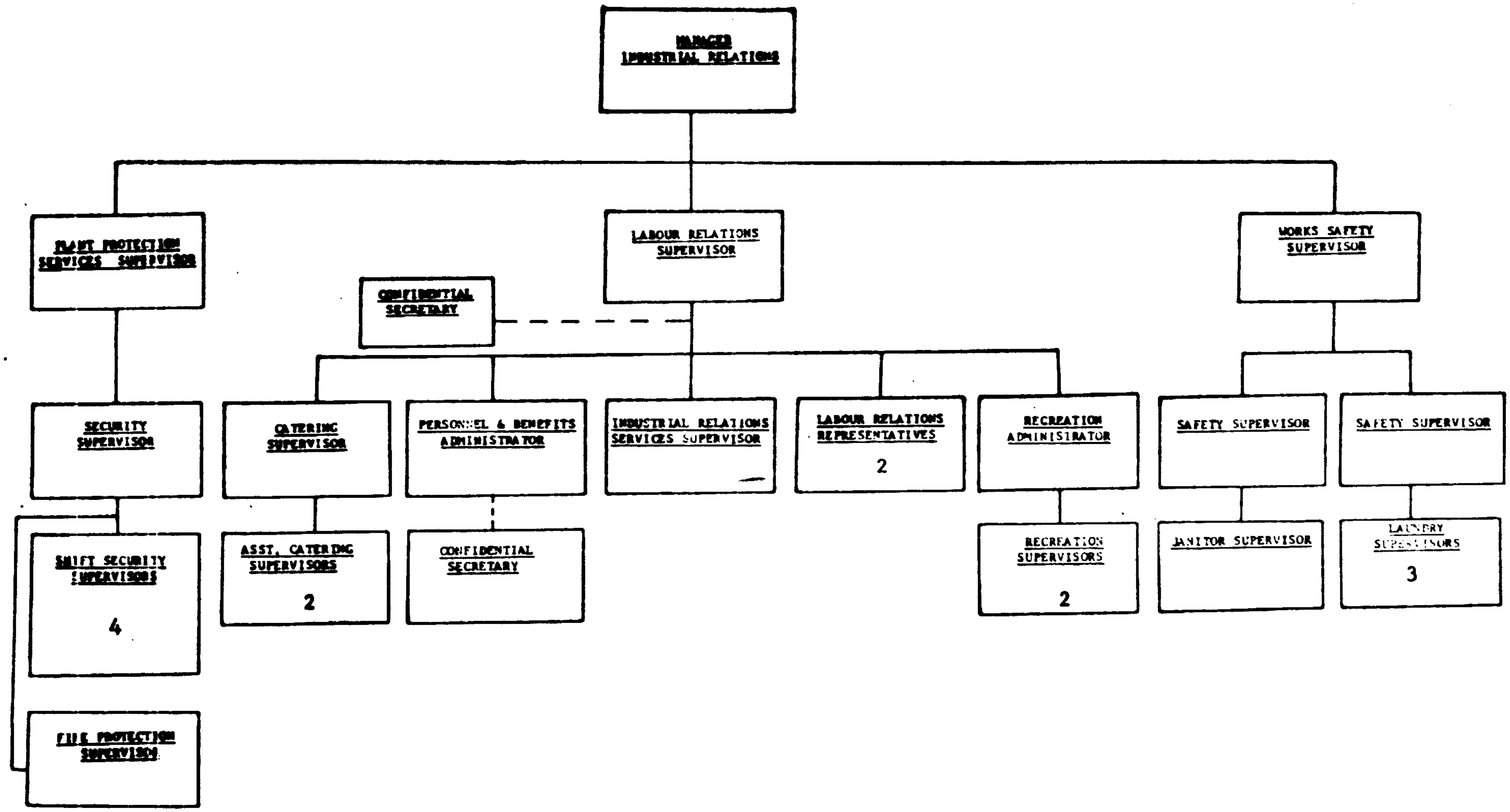
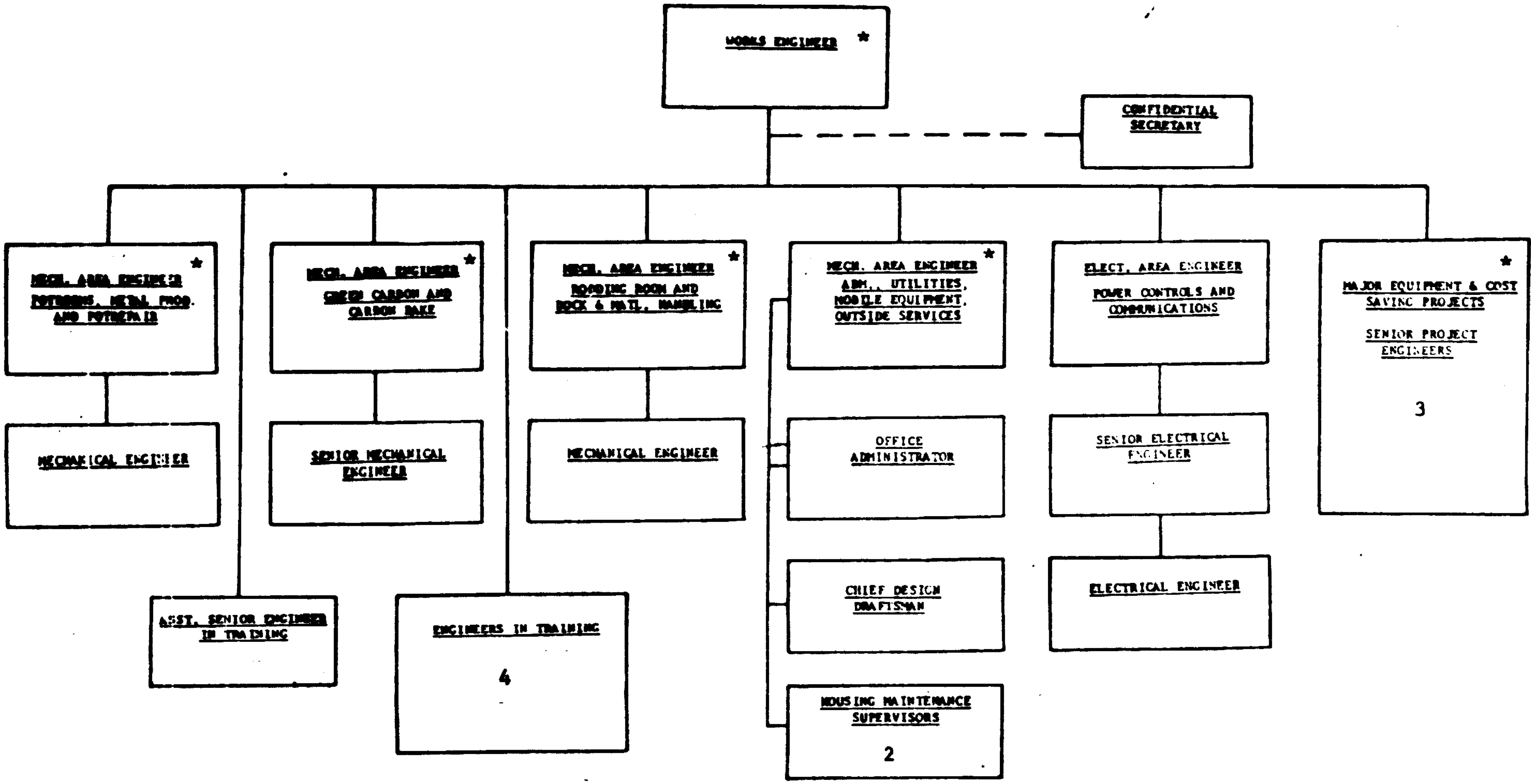

MANAGER INDUSTRIAL RELATIONS
PLANT PROTECTION SERVICES SUPERVISOR
LABOUR RELATIONS SUPERVISOR
WORKS SAFETY SUPERVISOR
CONFIDENTIAL SECRETARY
SECURITY SUPERVISOR
CATERING SUPERVISOR
PERSONNEL & BENEFITS ADMINISTRATOR
INDUSTRIAL RELATIONS SERVICES SUPERVISOR
LABOUR RELATIONS REPRESENTATIVES
2
RECREATION ADMINISTRATOR
SAFETY SUPERVISOR
SAFETY SUPERVISOR
SHIFT SECURITY SUPERVISORS
4
ASST. CATERING SUPERVISORS
2
CONFIDENTIAL SECRETARY
RECREATION SUPERVISORS
2
JANITOR SUPERVISOR
LAUNDRY SUPERVISORS
3
FIRE PROTECTION SUPERVISOR



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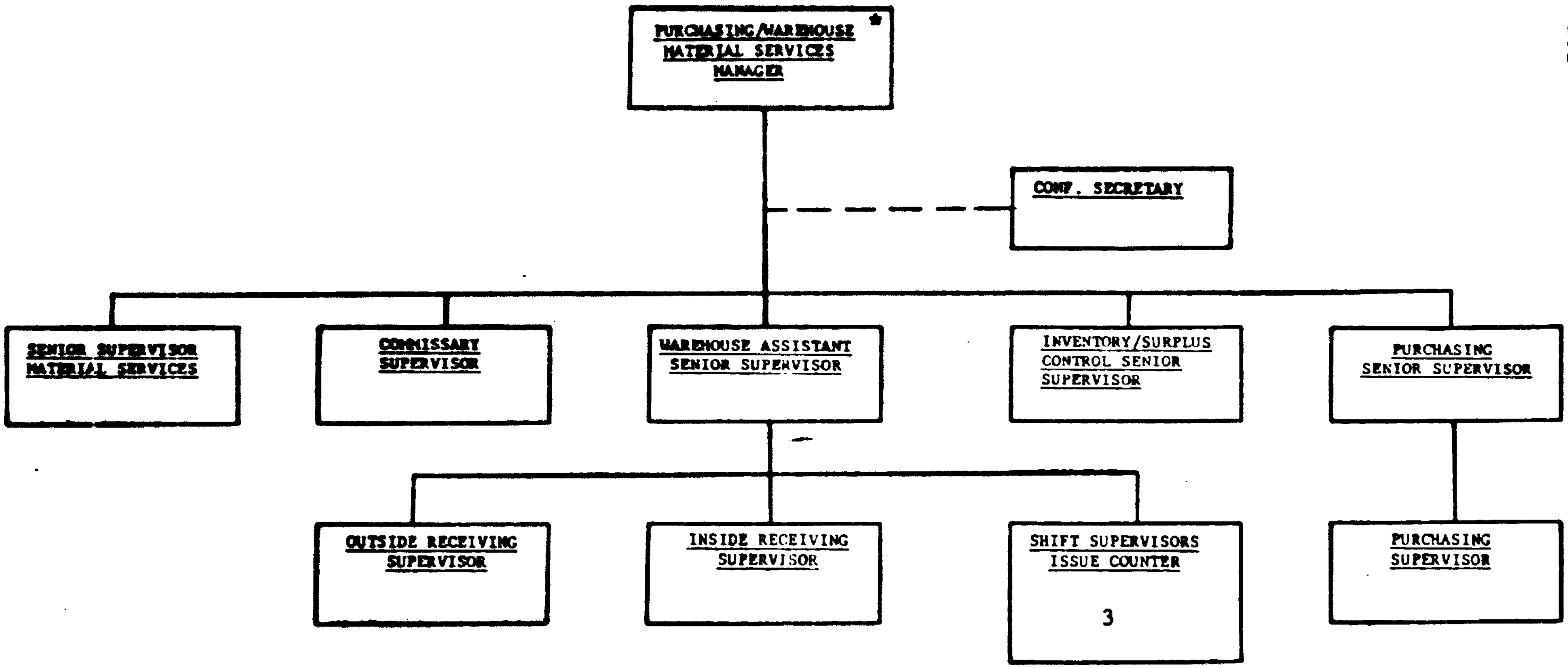

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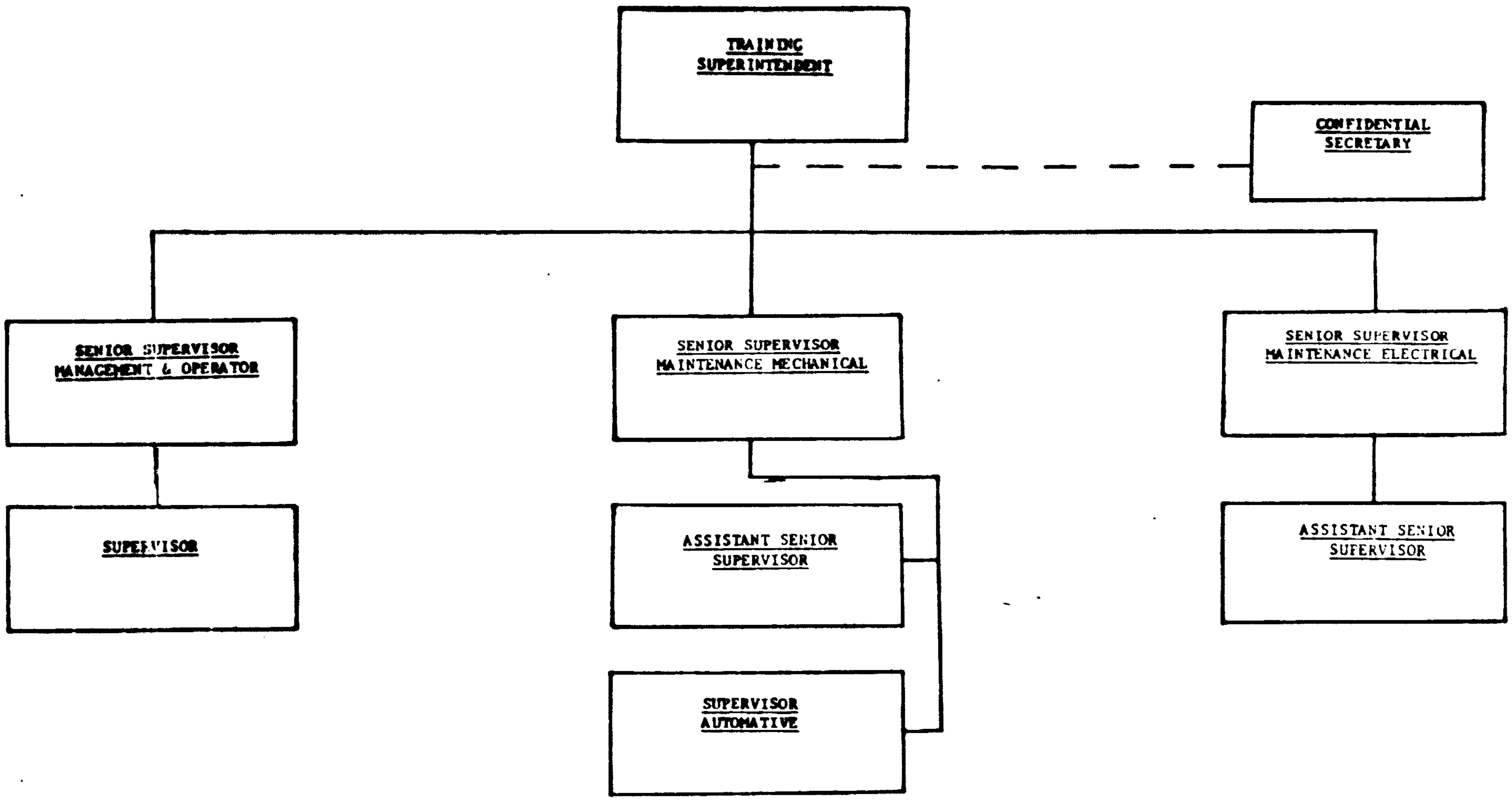
TRAINING SUPERINTENDENT
CONFIDENTIAL SECRETARY
SENIOR SUPERVISOR MANAGEMENT & OPERATOR
SENIOR SUPERVISOR MAINTENANCE MECHANICAL
SENIOR SUPERVISOR MAINTENANCE ELECTRICAL
SUPERVISOR
ASSISTANT SENIOR SUPERVISOR
SUPERVISOR AUTOMATIVE
ASSISTANT SENIOR SUPERVISOR

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